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SOVIET ACHIEVEMENTS IN OPTICAL CABLE COMMUNICATION SYSTEMS

Moscow ELEKTROSVYAZ' in Russian No 12, Dec 80 pp 1-2

[Unsigned Article]

[Text] In the Tenth Five-Year Plan, the scientific and engineering potential of our country has increased significantly. The economic strategy of the party formulated at the 24th and 25th CPSU Congresses has been realized. The relations of science to practice have been strengthened in all branches of engineering, including electrocommunications.

Along with the introduction of new equipment on the communication networks to improve the quality and efficiency of information transmission, theoretically new prospective areas of science and engineering have been developed. One of them is optoelectronics, on the basis of which, in particular, wide-band communication systems have been created which have many additional possibilities. Progress in the field of optoelectronics is proceeding intensely both in the USSR and in other economically developed countries.

Optoelectronic devices operate in the quite narrow, visible spectrum of electromagnetic oscillations from 10^{14} to 10^{15} hertz. However, this wave spectrum has turned out to be sufficient to see that the engineering based on optoelectronics has acquired basic qualititative differences from tube and transistor engineering and other predecessors of it. Broad horizons have been opened up for the practical use of optoelectronics systems in various branches of the national economy -- in nuclear power engineering, machine building, space research, cybernetics, medicine, holography, sound recording, and so on.

The optical frequency range exceeds by thousands of times the range used by electronics today, and it, correspondingly, insures greater carrying capacity of the optical transmission channels. In the optical range it is possible to obtain, for example, up to 10^6 standard voice-frequency channels. The information carriers in optoelectronics -- photons -- are neutral in electrical respects. They do not interact with each other and they are not sensitive to external electromagnetic interference.

The most important planning factor in the development of optoelectronics for communications purposes, that is, for purposes of transmission, conversion, processing and storage of information, was the appearance of the optical quantum generator -- laser -- at the end of the 1950's, the creators of which, as is known, were Soviet scientists, presently academicians N. G. Vasov and A. M. Prokhorov. The laser has coherent radiation; it has a narrowly directional beam and provides for transmission of an enormous information flux to in practice any required distances with a unimodal system.

The work on the creation and the introduction of optical communication lines is being performed everywhere. For ground and space communications, laser lines in open space are used. However, these "open" lines do not have the necessary reliability and transmission range, in view of subjection to the effects of atmospheric, climatic, industrial and other interference.

Under these conditions the radical means of establishing high-quality communications at large distances are the application of optical cables in which the role of the guide system is played by fiberglass light guides. The initial material for them is quartz, the reserves of which are unlimited. The urgency and usefulness of the application of optical cables instead of electrical ones arises to a high degree from the limited copper and lead resources in the world extraction budget; it is impossible to forget that the cable industry requires up to 50% of the copper and 25% of the lead in the total reserves.

The necessity for saving deficit nonferrous metals was especially emphasized in the reports by comrade L. I. Brezhnev at the November 1979 and October 1980 Plenums of the Central Committee of the CPSU, and will enter into the 11th Five-Year Plan and the five-year plans of subsequent years as one of the basic areas of development of the national economy.

The advantages of optical cables by comparison with electrical ones are also the wide-band nature, the possibility of transmitting a large information flux, low signal damping, independence of the losses with respect to frequency in a wide frequency band, good protection against external electromagnetic interference, small size, lightness (the weight of the optical cables is 12 to 10 times less than the electrical cables), suitability for laying in the existing underground structures and directly in the ground.

Losses in the optical cables on transmission on a wave 0.8 microns long do not exceed 5 decibels/km, which requires installation of repeaters approximately every 8 km. Recent studies have demonstrated that with transition to a wave 1.3-1.6 microns long, the damping decreases to 0.8 decibels/km, and this permits the length of the repeating section to be increased to 50-80 km.

The engineering economics comparison demonstrated that in the future, with mass production the optical cables will be competitive with electrical cables in meeting the demand for bunches of digital channels, beginning with the year 2000. A significant factor in reducing the cost of optical cables is improvement of the optical fiber production technology.

It is possible to state without exaggeration that the arrival of optical commmunication cables to replace electrical ones has the same significance for science and engineering as replacement of vacuum tubes by transistorized devices in radioelectronics had in its time.

Optical communication cables and systems have been developed primarily for constructing trunks between the city automatic telephone offices where they replace the highly metal-consuming electric cables with copper conductors. They are also used in local networks for transmitting wide-band information — cable television, video telephone communications, and so on. In the future the plan calls for using optical cables on intrazonal and main communication networks. Effective use of optical systems and cables in computer and measuring complexes, for communications inside mobile objects -- installations, organizations, and so on, aircraft, spacecraft, ships and other mobile units -- is also known.

In the USSR in a number of Moscow rayons there are already several experimental optical communication lines in operation on which digital transmission systems (IKM-30 [PCM-30], IKM-120 [PCM-120]) have been installed. There are projects working on the construction of optical lines also in other cities of the country.

In the Soviet Union a significant contribution to the creation of fiber light guides with good transparency and high transmission indexes has been made by the collectives of specialists under the direction of V. A. Kotel'nikov and A. N. Prokhorov. In the field of transmission theory over fiber light guides, Soviet scientists V. F. Vzyatyshev, I. I. Grodnev, V. Z. Katsenelenbaum, N. A. Semenov, I. I. Teumin, and V. V. Shevchenko have obtained important results. The creation of optical cables and communication systems is the work of collectives of specialists under the direction and with the participation of O. I. Gorbunov, V. P. Inozemtsev, A. G. Muradyan, V. F. Suchkov, and so on.

The studies in the field of optical cable communication systems are proceeding on a broad front and very intensely. Just as in any other new area of engineering, during the course of developments, ever newer complex problems are arising; the principles of the classification of optical cables, devices, systems and terminology have not been finally established, and there are no standards.

In order to provide information to specialists, the board of editors of the journal ELEKTROSVYAZ' [Electrocommunications] made the decision to publish this thematic issue devoted to optoelectronic cable communication engineering. This issue encompasses a number of problems connected with the theory, the engineering design, development and application of optical cables. A study is made of the structure of the optical communications systems, optoelectronic devices, information transmission equipment, cable structural elements, the procedures and equipment for taking measurements and installing optical cable lines. Surveys were made of the state of the art in optical cable engineering abroad. An article on the classification of cables, basic terms and definitions is printed for discussion.

The publication of materials on the given topic will continue in the form of thematic selections in subsequent issues.

The board of editors hopes that the publication of this issue will promote accelerated development of the prospective branch of engineering represented by optical cable communications, and that the issue will be useful to scientific workers, developers of cables and equipment and the specialists of the communication enterprises, teachers at the institutions of higher learning, technical schools and postgraduates.

The curator of this thematic issue was I. I. Grodnev, and the consultant was A. G. Muradyan. The editors express to them and also the authors and active members of the review board their appreciation for supporting the idea to publish this issue and help with its publication.

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STATE OF THE ART AND PROSPECTS FOR THE DEVELOPMENT OF OPTICAL COMMUNICATION CABLES

Moscow ELEKTROSVYAZ' in Russian No 12, Dec 80 (received 3 Jun 80) pp 12-15

[Article by V. F. Suchkov, Yu. T. Larin, and V. V. Shitov]

Advantages of Optical Cables and Requirements on Them. The development of repeaters that emit electromagnetic energy in the wave range of λ = 0.6 to 1.3 microns predetermines the possibility of transmitting light electromagnetic energy to a distance. It is possible to use a glass optical fiber (OV) as the guide system for propagation of the light electromagnetic energy. The quality and range of transmission depend on the construction and the optical characteristics of the OV, and the loss level of the light energy in the fiber determines its suitability for communication systems.

Optical communication cables (OKS) have a number of indisputable advantages over wave guides and communication cables with metal conductors: namely,

Absence of deficit materials in the cable structures;

Broader transmitted frequency band;

Ideal electrical insulation of the line;

Absence of danger of occurrence of short-circuiting on the line and equipment damage connected with this;

Absence of mutual interference from communication lines, high voltage cables and electric power transmission lines laid side by side;

Small size (outside diameter of the optical fiber is 100-250 microns) and small material consumption;

Absence of the necessity of shielding the cable and individual fibers;

Absence of the necessity for matching the wave impedance of the line sections;

Possibility of working in a wide temperature range;

Low attenuation factor of the transmitted signals (to 0.2 decibels/km on λ = 1.3 microns), which means, long distance between repeaters.

Optical cables have been developed for use on city telephone exchanges, data transmission networks between computers, and on mobile units. In the future the plan calls for developing OKS [optical communication cables] for transmitting information to significant distances.

Beginning with the conditions of laying, wiring, operating and maintenance, the technical requirements on the OKS basically coincide with the requirements on electric cables [1].

Let us present the basic requirements on OKS:

Optical fiber diameter with respect to reflecting sheath, microns	80, 100, 120, 150, 200, 250, 300, 400
Number of optical fibers	1, 2, 4, 6, 8, 10, 16, 20, 40
Number of conductors for remote feed	2, 4, 6
Outside diameter of the OK, mm:	
wiring	5
line	10-15
intrasite	5-14
Attenuation in the optical fibers, db/km, of the cables:	
wiring	5-15
line	3-5
intrasite	5-15
Operating temperature range	(-60 to +80)°C
Relative humidity at t = 40° C	to 98%
Operating radial pressure, MPa	to 50
No of cycles of sign-variable multiple 90° bends	from 100 to 10,000
Longitudinal rupture loads without destruction of the fibers, Newtons	from 50 to 2500
Local radial pressures, MPA	from 0.5 to 50
Service life, years	from 8 to 25
Factory length, meters	from 50 to 1000

Structural Design and Manufacturing Process Principles of OKS. When designing OKS it is necessary first of all to consider the most important characteristics of them, namely, the narrow limit of the elastic tension zone (to 0.5%) and low mechanical strength of the main element of the cable -- the optical fiber (the mechanical strength depends on the degree of uniformity of the material -- absence of microcracks accumulated in the fiber with time under the effect of loads).

Mechanical tests of the fibers made of multicomponent glass demonstrated that the rupture strength of a fiber 60 microns in diameter is on the average 250-300 MPa, a fiber 70 microns in diameter, 450-550 MPa. The strength of a quartz fiber 150 microns in diameter can be within the limits from 200 to 700 MPa.

Initially the structural elements of the OKS were polyfiber bunched conductors. The fibers in such a bunched conductor were more subject to microbending as a result of difference in their lengths than the monofibers. This bending leads to increased losses. The information transmission rate is reduced in such bunched conductors as a result of different propagation rates of the signal through the individual fibers. The improvement of the parameters of the light diodes while maintaining sufficiently high radiation power permitted replacement of the polyfiber bunched conductors by monofiber 120-150 microns in diameter with an inside core diameter of 60 microns and numerical aperture 0.2.

The structural elements of OKS with monofibers must insure increased strength in the longitudinal direction by comparison with electric cables. For these purposes, and also in order to limit the elongation of the cable, high-strength synthetic filaments are introduced into the OKS with modulus of elasticity within the limits of 60,000 to 100,000 MPa -- in the core of the cable, intermediate or protective polymer sheath. The reinforcing filaments must have small elongation and be in the stressed state in the cable. If these conditions are difficult to satisfy, it is necessary to insure a margin of length of the OV corresponding to the initial lengthening of the cable which with maximum tension can reach 2%. The margin of length of the fiber is achieved by twisting it or placement in endulating grooves of the cable core. Considering that contact pressures arise between the fibers in the cable core and the sheathing during longitudinal tension, the structural design of the OKS provides for damping separating layers or fillers. For more details on the structural design of the OKS, see [2, 3].

The protective-reinforcing polymer coatings of optical fibers can be of two types: dense without a clearance between the OV and the covering having sufficient adhesion to the surface of the fiber, and tubular for which the fiber is in the free state inside the tube.

The mechanical properties of dense and tubular coverings depend on the technological conditions of the extrusion process. High-density polyethylene (HDPE), F-2M fluoroplastic and polypropylene can be used as the materials for the sealed covering. When using a sealed covering of polypropylene and HDPE, the resistance of the fiber, for example, to the effect of radial loads is more than 10 times higher than the uncovered fibers. Measurements have demonstrated an increase in attenuation in the fiber after applying the covering obviously as a result of the occurrence of microcracks in the OV.

For tubular application of the polymer covering the main problem is exclusion of the adhesion of the fiber to the inside wall of the covering and breaks in the OV connected with this. The laying of the fibers in the tubular cavity of the covering frequently permits avoidance of critical bends causing an increase in the loss factor or rupture of the fiber. The given bending radii and cable diameters determine the geometric dimensions of the tubular covering of the OV, the outside diameter of which must not exceed 2 mm.

Some structural designs of the Soviet OKS are presented in Table 1.

Test Results and Prospects for the Application of the OKS. The OKS samples were tested for resistance to climatic and mechanical effects. During the process of mechanical testing, the minimum bending radius of the cable and maximum number of

90° bending cycles were determined. The resistance to bending was estimated by the number of broken fibers reduced to the total number of OV in the cable. The cable samples (six-strand 13.2 mm in diameter) were bent in ten cycles on rolls 26, 39, 50 and 65 mm in radius. Rolls 8, 16 and 32 mm in radius were used to test the single-strand OKS 4.5 mm in diameter. The minimum bending radius for the six-strand cable was established at 26 mm; for the single-strand cable, 8 mm. The maximum number of inflection cycles with double minimum radius of bending R = 50 mm for the six-strand cable is within the limits of 1000-1500 and for R = 16 mm for single-strand cable, within the limits of 100-200.

The maximum number of inflection cycles of the cable with eight strands laid in rectangular grooves of the core is 1000 for a bending radius of R = 90 mm and tension of 50 N. The preliminary tests for multiple inflections of an 8-fiber cable on a roll 66 mm in diameter with tension of 20 N demonstrated that even for 2000 cycles the fibers remain unbroken.

The tests run on the OKS for resistance to longitudinal loads demonstrated that the six-strand cable withstands a load of 294 N without rupture of the fibers; the 8-strand cable withstands 490 N; the single-strand cable, 49 N.

The tests were performed in the following sequence: vibration, multiple impacts, single impacts, thermal stability +80° C for 96 hours, moisture resistance, humidity 95 ± 3% for (40 ±2)° C for six days, cold resistance at -60° C for 2 hours. It was established that after the climatic and mechanical tests of all types, no external defects were detected in the cable samples or ruptures of the fibers.

Before performing the tests and after them, the attenuation was measured in the OKS samples for $\lambda = 0.63$ and 0.9 microns.

The variation of the attenuation in the samples of single-strand OKS after mechanical and climatic testing of all types is shown in Table 2.

The results of measuring the amount of attenuation in the mockup of an eight-fiber optical cable (fiber in a tubular cover of fluoroplastic with outside diameter of 2.4 mm and radial thickness of 0.4 mm) after the effect of mechanical factors are presented in Table 3.

From Table 2 it follows that the attenuation of the single-strand cable at $\lambda = 0.63$ micron after testing varied within the limits of 1.6-3.9 decibels, and at $\lambda = 0.9$ micron, within the limits of 0.2-3.5 decibels. The amount of attenuation of the seven-strand cable after the effect of increased temperature varied from 2 to 3.5 decibels. The effect of increased moisture and frost also caused a damping increment in the seven-strand cable by 1-2 decibels on the average. The increase in the attenuation in the OKS strands takes place obviously as a result of the negative effects on the parameters of the ends of the measuring tips.

The variation of the attenuation after the effect of mechanical factors is also observed in the eight-fiber optical cable. Thus, it is possible to draw the conclusion that the OKS with bunched conductors and monofibers are always resistant to mechanical and climatic effects and can be used under the same conditions as electric cables.

Table 1

Basic structural elements	Units of measure	Cable		
		Wiring	Intra-site	Line
Diameter of optical fibers with respect to reflecting sheath	mm	0.08	0.08	0.15
No of fibers in the cable:				
bunched conductors		7 or 19	7 or 19	--
monofilaments		1, 2, 4	6, 7	8, 10
Outside diameter of the OV with respect to the cover:				
tubular	mm	2.0-2.2	2.0-2.6	2.0-2.2
dense		0.7	0.7	0.7
Sheath diameter	mm	4.5	13.2	14.5
Reinforcing synthetic filaments:				
in the cable sheathing		none	used	used
in the cable core		none	used	used
Loss factor of the cable:	db/km			
bunched conductors		to 100	to 50	to 30
from monofibers		to 10	to 15	< 10
Rupture load of the cable	Newtons	50	300	500
Lay of the OV	mm	80-100	100-120	120-150
Factory length	m	50	100-200	> 250

Table 2

Sample No	Amount of attenuation, db			
	λ = 0.63 microns		λ = 0.9 microns	
	initial value	after test.	initial value	after testing
1	12,8	14,4	10,3	10,5
2	12,5	15,7	12,3	15,8
3	11,5	15,4	12,1	—

The different purposes of OKS are dictated by the necessity for standardization of them. Considering that the optical parameters and the geometric dimensions of the OKS are determined by the initial characteristics of the optical fiber and type of protective cover, it is necessary above all to standardize the types and classes of protection of optical fibers, the tolerances on the fiber diameter, the rupture strength of the OV, minimum bending radius of OV and OKS, the admissible number of inflections, the admissible number of twists, the loss factor, and the factory length of the segments of the fibers.

The application of fibers of various types (multimode and low-mode; two-layer and gradient; unimodal) with small loss factor (to 2 db/km) in optical cables permits transmission of information at a rate from 32 to 140 Mbits/sec for a repeating section length of 6-15 km.

Comparative data for transmission systems with PCM over electric and optical cables are presented in Table 4. From the table the conclusion is drawn of the prospectiveness of using OKS on various communications networks.

Table 3

OKS Sample No	Fiber No in OKS	Initial loss in OV, dB	Losses in OV, dB, after the effect of			Length of OKS sample, m
			Vibration	Multiple impact	Single impact	
1	1 4 8	1,4 3,9 3,0	1,7 4,3 2,24	2,3 3,5 2,5	2,09 3,5 2,6	35
2	4 7	2,8 1,9	2,3 1,2	3,9 1,05	3,8 1,5	28
3	3 4	1,4 1,3	1,5 1,3	1,61 1,25	1,32 1,72	25

Table 4

No of channels	Lines using electric cables		Lines using OKS	
	Type of cable	Length of repeating section, km	Fiber type	Length of repeating section, km
30	SK NCh	2-3	Multimode, 2-layer	5.5-14.0
120	SK VCh KK $\frac{0.7-2.5}{1.2/4.4}$	3-6	Multimode, 2-layer	5.0-12.5
480	KK $\frac{0.7/2.8}{1.2/4.4}$	1.5-3	Multimode gradient	4.5-11.2
1920	KK $\frac{1.2/4.4}{2.5/9.4}$	1.5-3	Multimode gradient or unimodal	4.0-10.0
7080	KK 2.5/9.4	1.5	Unimodal	3.0-7.5

Note: SK -- symmetric cable, KK -- coaxial cable, NCh -- low-frequency, VCh -- high-frequency.

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STANDARDIZATION OF OPTICAL CABLES

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[Article by A. V. Vlasov, I. I. Grodnev, V. P. Inozemtsev, D. D. Rumyantsev and V. S. Savchenko]

Terms and Definitions. Classification. Dimensional-Parametric Series

Printed for Discussion

[Text] In recent years definite experience in the development and the operation and maintenance of experimental optical cable communication systems (OKSS) and experience in the industrial manufacture of optical cables (OK) and line elements has been accumulated.

The trend toward the expansion of the sphere of application of OK [optical cables] in various branches of engineering has become clear.

It is important that at the beginning of industrial assimilation of the cables, a system be developed for standardizing the elements of optical cable communication lines (OKLS). The first step in the creation of such a system must be the development of terms and definitions. The necessity for them arises from the fact that at the present time many organizations are studying optical transmission systems and cables, and specialists are talking in "different languages" in view of the absence of established terminology, which complicates the joint work of the scientific research institutes, industry and customers. Thus, an optical fiber is also called a light guide, dielectric wave guide, fiber light guide, fiber, optical wave guide, glass filament, and so on. When the transmission characteristics of the optical channel, for example, pulse broadening, are investigated, the following terms are used: dispersion, modal delay, pass band, time delay, and so on.

In this article, on the basis of Soviet and foreign development experience in the area of optical communications systems and the results of discussing the problems of standardizing the OK at the meetings of the International Electrotechnical Commission MEK (committee 46E) in Ottawa in October 1979, an effort was made to formulate the basic terms and definitions, and proposals were made with respect to the classification of OK and the version of dimensional-parametric series of OK.

The recommendations discussed in this article, which are of a preliminary nature, can after discussion serve as the basis for preparing the corresponding All-Union State Standard.

Terms and Definitions. The terms pertaining to optical cables on the part of traditional elements (such as sheathing, winding, fillers, and so on) are regulated in [1]. The specific terminology requiring development and approval in the field of optical cables is connected with the use of optical fibers (OV) as the transmitting medium, the introduction of new characteristics not available in the terminology pertaining to electric cables, and the area of application of optical cables.

It appears expedient to isolate three groups of terms and definitions pertaining to the following, respectively: the construction of the cable, the optical characteristics and classification attributes which are related to the sphere of application of the optical cables.

The terminology pertaining to the construction of optical cables obviously must quite completely reflect the peculiarities of the structural design of the fibers and the peculiarities of the execution of the structural elements of optical cables. Significant attributes of an optical fiber include the presence of a light-conducting core (SV), reflecting sheath (OO) and protective covering (ZP) required to protect the OV from external effects during transportation, storage and the technological conversions during the process of manufacturing the OK. The nature of the dependence of the index of refraction of the core of the fiber on its radius determines the type of OV: it can be two-layer, with an index of refraction of the SV independent of radius, or gradient, the index of refraction of which varies smoothly on going away from the OV axis. There are optical fibers of other types with more complex (for example, W-type) dependence of the index of refraction of the SV on the radius. However, with a certain degree of conditionality they can be classified either as layered or gradient OV.

A very important characteristic of a fiber light guide (VS) is the relation between the wavelength, geometric dimensions of the OV core and the distribution of the indexes of refraction as a function of the core radius.

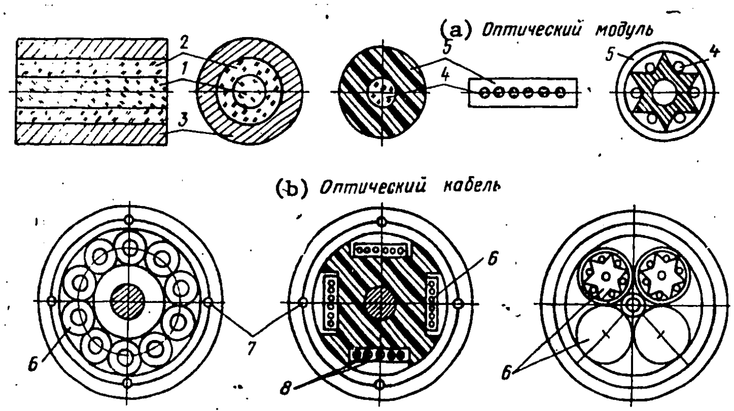
For theoretical analysis of the process of propagation of the optical signal and selection of the structural design of the radiation input junction, unimodal (small-load) VS and multimodal VS are theoretically distinguished. The basic advantage of unimodal light guides is minimum broadening of the pulse, limited in practice only by the dispersion of the material. The qualitative difference of unimodal VS from multimodal is connected with the conditions of propagation of electromagnetic energy, and it consists in more rigid requirements on the uniformity of the OV and the tolerances on its geometric dimensions.

The terms and definitions pertaining to optical fiber and the structural elements of optical cables are presented in Table 1.

The term "optical modulus" (OM) has been introduced to distinguish an OV that is in the known sense an analog of the current conductor in an electric cable (that is, "material") from the completed structural element of the cable consisting of the fiber, the protective-reinforcing elements and sheathings. The elements of an electric cable such as the insulated conductor, spiral quad, shielded group, reinforced group in communication cables, and so on can serve as the analog of the OM [optical module]. In practice the OV are used in OK only in the composition of the OM as a result of low mechanical strength of the fiber.

The term "optical module" pertains to the optical cable consisting of monofilaments, that is, to the OK in which each optical fiber serves as an independent signal transmission medium in the cable. For the case where a bunch of optical fibers in a common sheathing is used as a single transmitting medium (optical channel), the term "optical bunch" (OZh) is introduced.

Figure 1 illustrates the presented terms.



1 -- fiber core (SV), 2 -- reflecting sheath (OO), 3 -- protective cover (ZP), 4 -- optical fiber (OV), 5 -- module sheathing, 6 -- optical module, 7 -- reinforcing elements (AE), 8 -- service conductors.

Key: a. optical module b. optical cable

The basic optical characteristics of OK determining the optical and information indexes of the communication line, as is known, are the attenuation as a result of losses in the cable, the pass-band width of the frequency spectrum of the useful signal (for analog information transmission systems), pulse broadening (for digital transmission systems), crosstalk attenuation between the optical fibers in the cable. This group also includes the indexes characterizing the aperture angle of the OV. The corresponding definitions are presented in Table 1.

The terms and definitions pertaining to the classification attributes of OK must not contradict the established classification system in cable engineering. This system includes three (or more) hierarchical levels. The first level characterizes the class of products; these are the conductors and the cables. The second level characterizes the type of cable product depending on its purpose: power cables, communication cables, wiring, windings, and so on [1]. The classification of products on the third level is made, as a rule, by the basic parameters of the dimensional-parametric series, for example, by the thermal stability class (maximum operating temperature), the operating voltage, and so on. Then the cable products can, depending on the complexity of the cable, be classified with respect to secondary structural attributes or characteristics.

Each type of cable classified on the second or subsequent level must have its dimensional-parametric series.

Applying such a system for optical cables, we must begin the classification with the second level. With respect to purpose it is possible to isolate the following types of OK classified on the basis of the attributes characterizing the extent of the OKLS and the conditions of laying it (see Table 1): wiring (tens of meters); intrasite (hundreds of meters); intersite (several kilometers); line (long distances). It is obvious that for the first two types the basic parameter is attenuation; for the last two the basic parameter is attenuation and pulse broadening (the pass band).

The classification on the third level is determined by the system of parameters for each type of OK and is investigated below.

Table 1. Optical cables, basic terms and definitions

Item Nos.	Terms	Abbreviation, letter designation	Definitions
1	2	3	4
1.	Optical fiber (fiber light guide)	OB VS	Dielectric wave guide in the optical band, circular cross section, consisting of a core, reflecting sheath and protective cover
2.	Fiber core	SV	Light conducting part of the OV with average value of the index of refraction n_1 larger than the index of refraction of the reflecting sheath n_2
3.	Reflecting sheath	OO	Cover of the OV core with index of refraction $n_2 < n_1$
4.	Protective cover	ZP	Polymer cover applied to the OO for its protection against external effects
5.	Absorbing sheathing	PO	Cover applied over the OV in order to keep light energy from being radiated into the surrounding space
6.	Layered fiber	SV	Optical fiber for which the index of refraction varies discretely from layer to layer and in the core n_1 = const
7.	Gradient fiber	GV	Optical fiber with smooth variation of the index of refraction of the core from the center of the fiber to its periphery: $n_1=\psi(r)$
8.	Unimodal fiber	OMV	Optical fiber designed to transmit a wave of one type
9.	Multimodal fiber	MMV	Optical fiber designed to transmit waves of a large number of types
10.	Optical module	OM	Structural element of the cable consisting of one or several OV and reinforcing elements in a common sheath where each OV is an independent transmitting medium

Table 1 (continued)

Item Nos.	Terms	Abbreviation, letter designation	Definitions
1	2	3	r
11.	Optical bunch	OZh	Several OV without protective covers grouped together having a common sheathing and used as a single transmitting medium
12.	Optical cable	OK	Cable product containing several OV, OM or OZh included in a common sheathing, over which the protective cover can be applied depending on the conditions
13.	Reinforcing element	AE	Structural element of the OK with high modulus of elasticity insuring increased rupture strength of the OK
14.	Aperture angle	A	Angle between the input vector of the radiation and the OV axis
15.	Numerical aperture	NA	Index numerically equal to the product of the sine of half of A times the index of refraction of the transmitting medium that is outside with respect to the end of the OV
16.	Pulse broadening	$\Delta\tau$	Parameter characterizing the distortion of the shape of the pulse of optical radiation on passage through the OV; it is defined as the square root of the difference of the squares of the durations of the input and output pulses with respect to the level 0.5 reduced to the length of the OV; it is measured in milliseconds/km
17.	Pass band	ΔF	Parameter characterizing the frequency range of the optical signal transmitted through the OV without significant distortions and defined as the upper frequency of the modulated signal for which its amplitude in the OV of the given length is decreased by 3.0 db. The width of the pass band is measured in megahertz-km.
18.	Loss factor	α	Value characterizing the attenuation of the optical signal on propagation through the OV measured in db/km under the established conditions
19.	Crosstalk attenuation	A_{π}	Value characterizing the relative amount of energy transmitted from one OV to another; measured in decibels
20.	Optical characteristics		Set of parameters determining the conditions of propagation of electromagnetic waves in the optical band through an optical cable (losses, pass band, pulse broadening, crosstalk attenuation, and so on)

Table 1 (continued)

Item Nos.	Terms	Abbreviation letter designation	Definitions
1	2	3	4
21.	Optical channel		Set of optoelectronic devices (equipment and cable) providing for the transmission of optical signals from one station to another
22.	Optical connector		Device designed to connect two OV when installing the OK and also for connecting OV with optoelectronic devices
23.	Split optical connector		The same, but providing for the possibility of multiple connection and disconnection
24.	Optical coupler		Device designed for coupling three or more OV to distribute the energy with respect to different channels
25.	Wiring OK		Optical cables designed for intramodular and intermodular wiring of equipment
26.	Intrasite OK		Optical cables designed for transmitting information within a site
27.	Intersite OK		Optical cables designed for information transmission between sites
28.	Line OK		Optical cables designed to transmit information on local, zonal and main communication networks
29.	Optical cable communication line	OKLS	Line consisting of factory lengths of OK installed using optical current connectors
30.	Optical cable transmission system	OKSP	Systems and technical means providing for the creation of a line channel and transmission channels
31.	Optical cable communication system	OKSS	The set of devices providing optical communications over cable lines including the transmission system, optical cable, optoelectronic equipment, switching and matching devices

In Table 1 definitions of connectors, couplers, optical cable communication line and communication system are presented, without which the list of terms and definitions would suffer.

Optical Parameters and Dimensional-Parametric Series. The list of parameters and dimensions of optical communication cables subject to standardization must be established beginning with the necessity for parametric, structural and operating maintenance compatibility of the OKLS components, their efficient, most effective use when designing communication lines. The indexes can be broken down into two basic groups:

optical and information;

characterizing the operating reliability of the OKLS.

The information-optical characteristics of the OKLS determine the length of the line over which the information is transmitted without distortions. For extended lines these indexes characterize the length of the repeater section.

For the given admissible probability of error in the selected code the length of the repeater section is limited either by the attenuation or the broadening of the pulse in the line [4]. It is possible to consider approximately that the admissible length of line without repeaters, depending on the power of the transmitter W_{trans} and the loss factor α, can have a length

$$L = {}^1/_2\alpha \ln \frac{W_{\text{пер}}\,(a)}{W_{\text{пр}}\,(b)},$$

Key: a. trans b. rec

where W_{rec} is the sensitivity of the receiver.

Depending on the pulse broadening Δt for the distance τ between the pulses of duration t_0 and under the assumption of the absence of mode communication, the line length is limited [4] by the expression

$$L_1 = \left[\frac{\tau^2 - t_0^2}{\Delta\tau^2}\right]^{1/2}.$$

The losses introduced into the communication system by the optical cable itself are defined in the first approximation by the loss factor of the OK and the efficiency of the radiation input to the OV. As is known, it is proportional to the product of the diameter of the fiber core times the square of the aperture angle.

Thus, the information-optical parameters of the OK are determined by the values of the loss factor of the OK, the broadening of the pulse (for the digital transmission system) or pass band (for the analog transmission system), the numerical aperture and the core diameter of the OV.

The reliability indexes of the OKLS characterize its resistance to external operating effects and requirements on the wiring and laying. As the basic indexes determining the operating reliability of the OK, the thermal stability and rupture strength can be used. The thermal stability is related by Arrhenius law to the reliability indexes; the rupture strength defines the wiring characteristics of the cable. In addition, the system of basic parameters of the OK must be interrelated with the corresponding characteristics of the terminal devices and the connectors. This leads to the necessity for supplementing the series by the OV diameter with respect to the sheathing and the number of OV (OM) in the cable.

Thus, considering the classification on the second level, the system of basic parameters for the wiring and the intrasite OK must include the following minimum set of characteristics: the fiber core diameter, the diameter of the reflecting sheathing, the numerical aperture, the loss factor, the thermal stability, the rupture strength, the number of OV (OM) in the cable; for intersite and line OK the core diameter of the fiber, the reflecting sheath diameter, the numerical aperture, the loss factor, pass band (pulse broadening), thermal stability, number of OV (OM) in the cable.

The series of values of the basic parameters proposed for discussion are presented in Table 2.

Table 2. Basic parameters of optical cables. Dimensional-parametric series

Name of parameter	unit of measure	Value of the parameter of optical cable			
		Wiring	Intrasite	Intersite	Line
Loss factor, no more than	db/km	20; 40; 80; 160; 400	15; 20; 40; 80; 160	5; 10; 15	1; 3; 5
Pulse broadening	nanoseconds/km	not standardized		necessary to establish	
Pass band for 1 km and wavelength of 0.9, 1.3, 1.55 mi.	megahertz	not standardized		necess. to estab.	
Numerical aperture of fiber, no less than		0,2; 0,4; 0,6	0,2; 0,4; 0,6	0,2	0,1; 0,2
Fiber core diameter (rated)	microns	50; 60; 200; 400	50; 60; 200; 400	50; 60	15; 50; 60
Diameter of reflecting sheath (rated)	microns	125; 150	125; 150	125; 150	125; 150
Thermal stability	°C	70; 125; 200; 250	70; 125; 200; 250	70	70
Rupture strength, no less than	Newtons	10; 40; 100	40; 100; 250	not standardized	
No. of OV (OM) in the cable	pieces	1; 2; 4; 8; 16; 32	1; 2; 4; 8; 16; 32	4; 8	4; 8

Note. The cores with diameters of 50 and 60 microns correspond to reflecting sheaths with diameters of 125 and 150 microns. The diameter of the reflecting sheaths for a core size of more than 60 microns requires establishment later by the results of developing industrial types of OV.

The assumed values of the parameters with respect to the loss factor, the fiber core diameter, the number of OV (OM) and the rupture strength correspond to All-Union State Standard 8032-58 "Preferred numbers and series of preferred numbers."

The series of values with respect to thermal stability corresponds to the one adopted in Soviet practice for equipment and kit products.

The introduction of the series with respect to the pass band (or pulse broadening) and the core diameters and reflecting sheaths (with the exception of the established dimensions of 50/125, 80/200 microns) is, in our opinion, premature. These parameters can be established in the future by the results of the development of industrial types of fibers for long OKLS.

The proposed system of OK parameters is intended for use for OKLS of optical modules primarily based on monofilaments. The optical conductors are finding application in the OKLS requiring high flexibility and operating reliability.

The preferable application of multimodal OV is proposed for short OKLS — wiring and intramodular, low-mode fibers for linear and intersite lines.

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OPTICAL CABLE COMMUNICATION SYSTEMS FOR THE NATIONAL NETWORK

Moscow ELEKTROSVYAZ' in Russian No 12, Dec 80 (received 12 Sep 80) pp 3-6

[Article by A. G. Muradyan]

During the Tenth Five-Year Plan the length of the cable communication network of our country has grown significantly. The channels organized over the cable systems make up 73% of all the communication network channels. The local network is completely based on cable lines.

A further increase in the length of the cable lines in all links of the national communication network is planned. On the main network it is proposed that powerful transmission systems be introduced -- for 3600 or more telephone channels -- and on the local network, broad introduction of digital transmission systems is proposed.

When solving the problems of further development of the communication networks, a significant technical and cost benefit can be obtained from the application of optical cable communication systems (OKSS).

The first work on mastering the optical wave band for communication purposes belongs to the beginning of the 1960's. Ground layers of the atmosphere and light guides with periodic correction for divergence and beam direction by a system of lenses and mirrors were used as the transmission channel [1]. Open (atmospheric) lines turned out to be subject to meteorological conditions and did not provide the necessary communications reliability. Light guides with discrete correction were very expensive, they required careful adjustment of the lenses and the complex automated beam control devices. They did not find practical application on the communications network.

The creation of highly reliable optical cable communication systems became possible as a result of the development at the beginning of the 1970's of dielectric optical fibers (OV) with small losses. These fibers greatly stimulated the development of special equipment and line channel elements for optical cable transmission systems (OKSP) -- generators, photo receivers, split and unsplit connectors, couplers and other elements [2]. A number of structural designs for optical cables (OK) for various purposes were created [3].

The optical cable communication systems are characterized by significant advantages, the basis ones of which are the following:

1) significant savings of expensive and deficit nonferrous metals (silicon and its compounds form the base of an optical cable), the reserves of which are limited;

2) great length of the repeater section determined by small losses in the optical cable. On waves 0.8-0.9 microns long the modern OK have an attenuation factor of 3-5 decibels/km, and on waves 1.3-1.6 microns, 0.5-1.0 decibels/km. Therefore the length of the repeater section is 6-10 km in the wave range of 0.8-0.9 microns and 40-50 km in the wave range of 1.3-1.6 microns. Such lengths of sections in practice always permit location of the line repeaters on the local networks in the ATS [automatic office] buildings and do away with the necessity for organizing remote feed (DP). The calculations show that the application of cables with attenuation to 5 db/km permits the design of 85% of the interstation trunks on the local network without DP. The reliability of the network is increased, the labor-consuming operations of the installation, adjustment, operation, maintenance and repair of the unattended repeater stations (NIP) in the telephone corridors are excluded;

3) small dependence of the cable losses on the modulating frequency band. In optical cables having multimode fibers with step variation of the index of refraction, the pass-band width is 30-50 megahertz/km, and in cables with smooth variation of the index of refraction, 200-300 megahertz/km. When using single-mode fibers the width of the frequency band can reach 3000 megahertz/km. This offers the possibility of building up the capacity of the network without replacing the cable and increasing the number of NUP [unattended repeater stations];

4) the small dimensions and weight of optical cable, which permits efficient use of the expensive telephone corridors in the local network and greatly reduce the expenditures on transporting and laying cables;

5) high protection against external electromagnetic fields. The required magnitude of the crosstalk attenuation between adjacent OV [optical fibers] is easily insured by applying a thin polymer sheathing to the fiber which is simultaneously a protective and reinforcing coating.

The indicated advantages of optical cable systems predetermine the rates of development of this new field of communication engineering. The data from the information survey of Gnostic Concepts Inc. (United States) created for the analysis and prediction of the state of the art in the production and marketing of OKSS in various countries of the world are characteristic. The specialists consider that by 1990 the total volume of the world production of these systems expressed in cost will be 1.58 billion dollars (the system cost for commercial networks -- 77% of this total), considering a significant reduction in cost of optical fiber -- 10 to 20 cents per meter.

It must be noted that in the first step the optical cable systems are being introduced on the city telephone exchanges. This is connected with the preparation of the elements and equipment, simple solution of the problem of electric power supply for the intermediate repeaters and the presence of a telephone corridor. In addition, it is necessary to accumulate experience in the construction, operation and maintenance of such communication systems and evaluate their reliability. The second step is characterized by the preparation for the production of high-speed transmitters and receivers and systems for organizing large groups of channels on the main communication networks. The degree of integration of the elements and assemblies of the equipment is being increased.

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Figure 1 shows the standard structural diagram of an optical cable transmission line. The equipment of the digital transmission systems in all steps of the hierarchy is used as the terminal equipment 1, 8. Analog optical cable communication systems have still not found application. This is connected with defined difficulties in insuring high-quality indexes of the line channel required for the analog systems.

The line channel LT contains the following basic assemblies and elements: terminal equipment of the line channel OALT for transmission and reception, the line repeater Lin. reP. and optical cable OK with devices for splicing the factory lengths and the terminal split connectors. Figure 1 also shows: 2 -- the code converter, 3, 5 -- quantum electronic transmission and reception modules; 4 -- optical cable; 6 -- an electronic line repeater; 7 -- electronic receiving repeater and code converter.

Optical cable is characterized by the following basic transmission parameters: losses, pass-band or pulse characteristic and numerical aperture. The cable losses depend on the radiation wavelength and are caused by the presence of impurities in the glass (iron, copper, nickel), scattering as a result of nonuniformity of the material and also deviations from the rated geometric dimensions of the core and sheathing along the fiber and in the transverse cross section. A noticeable proportion of the attenuation (1-3 db/km) is the so-called "cable" or additional losses connected with the OK production technology (bending, twisting). Loss stability depends on the quality of the fiber. As experimental studies have demonstrated, in high-quality fibers with small losses the attenuation is very stable. There is a weak dependence of the attenuation also on the temperature; therefore OKSS of medium length do not contain automatic level controls.

The cable pass band depends on the type of fiber (unimodal, multimodal, with step or smooth variation of the index of refraction), and it is equal to 30-30,000 megahertz/km. The limitation of the width of the OV pass band is connected with the presence of propagation rates in the class of individual frequency components of the spectrum of the radiation source. Therefore if an incoherent light source with band width of the emitted frequencies (for example, a light guide) is used as the emitter, then the pass band of the optical system will be limited to approximately 80 megahertz/km.

When using a laser source having a narrower emission band, the pass-band width of the cable is broadened to several gigahertz per kilometer. Additional constriction of the width of the pass band (or broadening of the transmitted pulses) takes place in multimodal fibers as a result of different propagation rate of the individual modes. This effect is expressed most strongly in the OV with step variation of the index of refraction in which the pass band is constricted to 30 megahertz/km. The equalization of the speeds of the various modes is achieved in fibers with smooth variation of the index of refraction, the pass band in which reaches several hundreds of megahertz per kilometer.

For digital transmission systems, direct estimation of the pulse characteristic of the cable is also expedient. It offers the possibility of determining the degree of intersymbol interference and the necessity for using equalizers in the receivers. A decrease in the pulse distortions is achieved by selecting a quadratic distribution law of the index of refraction in the fiber core [4], which provides for equalizing the propagation rate of the different modes.

The efficiency of radiation input to multimodal fiber from the light source depends on the fiber core diameter and the numerical aperture A, which is defined by the sine of the maximum angle of input of the radiation θ_{max}.

The basic elements of the modern line channel equipment are the quantum electronic transmission and reception moduli (KEM) which are installed both at the terminal stations and in the line repeaters. They provide for conversion of the electric signals to optical and back with complete matching of the parameters -- both with the electronic system of the equipment (the code converters, electronic repeaters) and the optical cable.

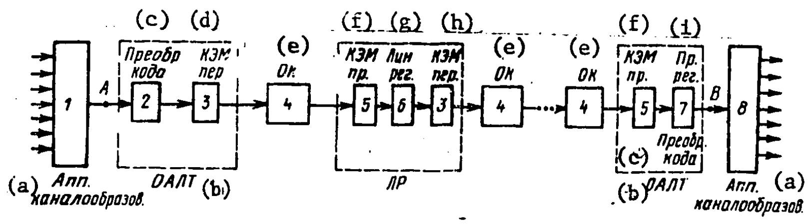

Figure 1.

Key:
- a. channel former
- b. OALT [terminal line channel equipment]
- c. code converter
- d. transmission KEM [quantum electronic module]
- e. OK [optical cable]
- f. receiving KEM
- g. line repeater
- h. transmitting KEM
- i. receiving repeater

As the radiation sources in the transmission KEM, laser diodes and light guides are used. The modulation characteristic of the laser diode has a clearly expressed threshold dependence with inflection point at the pumping points of approximately 200-300 milliamps, after which the emitted power increases rapidly. The light guide is characterized by linear dependence of the output optical power on the booster current.

The operating conditions of the laser diode must be stabilized, for significantly exceeding the threshold level leads to a reduction in service life and an increase in laser noise. In addition, the generation threshold increases with time and with an increase in the transition temperature. Therefore in the transmission KEM with laser diodes, provision is made for an automatic bias current regulation circuit for the laser. For this circuit part of the optical power (Figure 2) emitted by the laser diode 3 is fed to the photo detector 6 (as a rule, p-i-n-photo diode), and by using the circuit 7, the bias current is automatically regulated. The effectiveness of the energy input to the OV is determined by the core diameter and the numerical aperture of the fiber and also the emitting area and the radiation pattern of the light source.

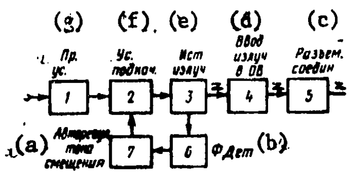

Figure 2.

Key:
- a. automatic bias control
- b. photo detector
- c. split connector
- d. radiation input to the OV [optical fiber]
- e. radiation source
- f. pumping amplifier
- g. intermediate amplifier

The energy input coefficient from the light guide with Lambert radiation pattern is defined by the expression $\eta = CA^2S_2/S_1$ if the core area of the fiber S_2 is less than the radiating area of the light diode S_1 and $\eta = CA_2$, if $S_2 > S_1$. Here C is the coefficient considering the losses to Fresnel reflection. From the presented relations it is obvious that for reduction of losses on input of the radiation it is necessary to decrease the dimensions of the radiating area of the light diode to the dimensions of the fiber core and increase the fiber aperture. These possibilities are limited, and in practice it is not possible to obtain small losses at the input. For example, if we take the diameter of the emitting area of the light diode as d = 350 microns, the fiber core diameter D = 75 microns and its aperture A = 0.14, then the losses at the input will be 31 decibels. With an increase in the aperture to A = 0.5 the losses are reduced to 20 decibels, and at the limit where $S_2 = S_1$, the losses at the input will be 17 decibels.

The light guides with double heterostructure have somewhat more directional emission than Lambert, and therefore the losses at the input are lower by 2-3 decibels. Such large losses limit the possibilities of the application of light diodes on the national network. They are used successfully on short intrasite lines.

In laser diodes, the losses are significantly less for radiation input (5-8 decibels) than in the light diodes. They have small emitting area and high directionalness of the radiation, which permits the use of optical matching elements (focons, lenses) in the input circuits 4 (see Figure 2). Simultaneously, these elements are used for the coupling of a radiation source with the return part of the optical plug 5 of the transmission KEM.

In the KEM, photodiodes with internal gain (LFD) and without it (p-i-n-structure) are used to convert light to electric current. The avalanche photo-diode has high sensitivity, but its pulse characteristic has a long drop which leads to intersymbol distortion during high-speed transmissions.

The optical cable is connected to the receiving KEM using a split connector 1 (see Figure 3). The amplification of the photo current is realized by the low-noise amplifier 4, the input resistance of which to a significant degree determines the signal/noise ratio at the KEM output. With the application of p-i-n-photo-diodes in order to decrease the resultant noise it is expedient to increase the input impedance

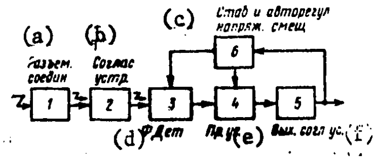

Figure 3.

Key: a. split connector
b. matching circuit
c. bias voltage stabilizer and automatic control
d. photo detector
e. intermediate amplifier
f. output of the matching amplifier

of the amplifier 4. As the matching circuit 2, usually a segment of the fiber is used with smooth variation of the index of refraction.

At the present time the repeating of the signal is being realized by electronic repeaters 6 and 7 (Figure 1) containing an equalizer, the device for optimal processing of the signals and decision making, and also the device for isolating the cycle frequency.

When selecting the line signal (code) it is necessary to consider noiseproofness of the code and its technical advantages. The noiseproofness is estimated by the minimum mean power of the signal at the input of the photoreceiver which insures a given quality of reception (for example, the error probability) against a background of photo detection noise, avalanche multiplication and thermal noise. The technical advantages of the code are determined by the high information content about the synchro-frequency (which simplifies the synchronization channel circuitry), the possibility of error detection in the line and receiving repeaters, simplicity of the code converters 2 and 7 (Figure 1), and minimum content of low-frequency components.

The optimal signal from the point of view of noiseproofness in the optical range is the PCM signal, the ones of which are transmitted by the pulse, and the zeros, by the interval. However, in this code there is theoretically no possibility of error detection, and there is a high content of low-frequency components.

For low-speed systems in which equalization of the pulse characteristic of the cable is not required, the following codes are used: bipulse, two-level with alternate inversion of the current signals and certain other mBmB codes. The code converters 2 and 7 (see Figure 1) are used in the terminal equipment of the line channel to convert the signals of the standardized channel-forming equipment 1 to the indicated line code. The enumerated peculiarities of the structure of the optical systems and the characteristics of the elements have been checked out for several years on experimental and commercial communication lines in various countries. In the Soviet Union such research has been performed since 1977 on several lines running up to 5 km put into experimental operation as city telephone exchange trunks. A comparison is made between the parameters of the lines built from laser and superluminescent diodes with the application of avalanche and p-i-n-photo detectors. The noiseproofness of the system was estimated for several types of line signals, including bipulse and AMI, class II type code. The error probability for the repeater section will be 10^{-9}. In this case the rated power at the input of the photo receiver fluctuated within the limits from $2 \cdot 10^{-7}$ to $5 \cdot 10^{-9}$ watts depending on the type of photo detector used.

Optical cables of circular design were tested with 4, 8 and 10 fibers, and combined cables with copper conductors were also used. Various methods of splicing the factory lengths of the optical cables have been checked out with the application of epoxy resins, aligning bushings and other methods. The junction losses are within the limits of 0.5 to 1.5 decibels, depending on the deviations of the geometric dimensions of the fibers and the quality of the installation. Under field conditions the welding technique is not used as a result of imperfection of the structural design of the installation attachments.

The optical cable was laid manually. While laying there were cases of breaking of the fiber. The terminal and intermediate equipment of the line channel was structurally executed in standard bays and placed in the automatic telephone office equipment rooms. The electric power supply for the equipment came from a station battery. In order to measure the cable and equipment characteristics, a power meter, attenuation meter and instrument for determining the location of cable breaks were used [6].

In the foreign literature generalized data have been published on the development, the production, operation and maintenance of optical cable systems used on different sections of the communications network. It is noted [5] that the operating reliability and high quality indexes obtained have determined the fast rates of development of production and introduction of optical cables.

The data obtained also permit formulation of the basic areas of further scientific research work. These include first of all:

1) the mastery of the new optical wave range of 1.3-1.6 microns in which the damping of the optical cable and dispersion are extraordinarily small. The process of industrial production of OV and elements for this range must be developed;

2) improvement of the degree of integration of the elements and creation of high-speed standardized assemblies for the channel-forming PCM equipment with the application of elements of integral optics;

3) the creation of optical repeaters without conversion of the optical signals to electric signals;

4) development of effective methods and electric power supply units for the intermediate generators for zonal and main communication networks;

5) optimization of the structure of various sections of the network considering the peculiarities of the application of the systems based on optical cable (including the subscriber telephone network, the data transmission, multiprogram cable television, video telephone and other networks);

6) mechanization of the process of laying and installing optical cables;

7) development of the measuring equipment required during production, adjustment, operation and maintenance of the set of equipment and the cables of the optical lines;

8) development of methods and equipment for frequency and time separation of the signals transmitted over the optical fiber;

9) development of a united terminology for this developing area of communications engineering.

The most important problem is improvement of the technology of the industrial production of optical fibers, which will lead to a reduction in their cost.

The solution of these problems will unconditionally promote improvement of the effectiveness of introducing optical cables on the communications network.

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OPTICAL CABLE DIGITAL TRANSMISSION SYSTEM FOR CITY TELEPHONE EXCHANGES

Moscow ELEKTROSVYAZ' in Russian No 12, Dec 80 (received 5 Aug 80) pp 31-36

[Article by O. I. Gorbunov, Yu. V. Svetikov, V. T. Khrykin]

[Text] The prospectiveness of optical cable information transmission systems (OKSP) is determined by their technical-economic advantages over transmission systems on cables with metal conductors. These advantages arise from such properties of optical cable (OK) as small loss factor (0.5-10 decibels/km) with large widebandedness, nonsusceptibility to the electromagnetic interference, small size and weight, significant savings of deficit nonferrous metals.

In many countries developments are proceeding for digital OKSP (OKTsSP) designed for organizing line channels. Channel-forming equipment with PCM in all stages of hierarchy is used for installation on the OK. The optical cables used as the transmission medium permit organization of communications between city automatic exchanges without repeaters and remote feed. On the intrazonal and main lines the number of unattended repeater stations (URS) is decreased significantly, which improves the technical-economic characteristics of the transmission systems.

In our country work is also being done to build digital transmission systems over optical cable for the city telephone exchanges. One such system with a transmission rate of 8.448 Mbits/sec was demonstrated at the Telekom-79 International Exhibition in Switzerland.

At the present time the equipment is being subjected to experimental operation.

Purpose and Composition of the Equipment. The OKTsSP complex was developed for use as the line channel equipment of the IKM-120 [PCM-120] digital transmission system [1], and it is designed for organization of two-way transmission of a group signal of 120 telephone channels over pairs of monofiber light guides making up the structure of the OK laid between the city automatic offices. The set includes the terminal equipment (the optical line bay SOL) and intermediate equipment placed in the unattended repeater stations of the fiber-optical communication line (NRP-VOLS).

The structural diagram of a communication line with OKTsSP is shown in Figure 1.

The OKTsSP complex provides for the performance of the following functions: matching of the channel-forming equipment IKM-120 --an SVVG temporary group formation bay -- with the optical transmission channel; transmission of the information signal; remote control of the unattended repeater station from the main office; operator link between the SOL and any NRP [unattended repeater station]; remote feed of the NRP.

The terminal equipment includes the equipment of the optical information channel (OIT), the optical remote control and operator link channels (OTTS), the general-bay servicing and remote feed device (DP).

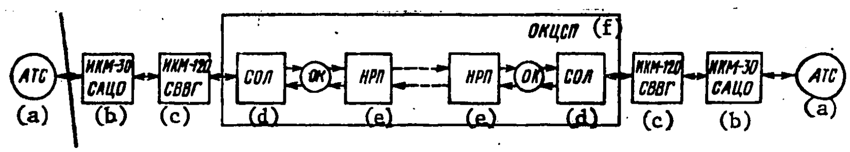

Figure 1.

Key:
a. automatic office ATS
b. IKM-30, SATsO
c. IKM-120, SVVG
d. SOL
e. NRP
f. OKTsSP

The structural diagram of the terminal equipment of the optical information channel is shown in Figure 2. It provides for matching of the VVG IKM-120 equipment with the optical cable line (OKLS). The input and output signals of the VVG are a train of pulses in HDB-3 code not suitable for transmission over the OKLS. It is known that the following basic requirements are imposed on the line signal code: the presence in the signal spectrum of a channel frequency component, minimum level of the constant component, the possibility of detecting errors in the transmitted signal without interrupting the process of information transmission, simplicity and economicalness of the circuit designs. For the OKTsSP with a speed of 8.448 Mbits/sec the 1B2B type biphasal code was selected which basically satisfies the enumerated requirements.

The transmitting part of the OIT equipment consists of the transmission code converter (HDB-3→1B2B) and the optical transmitter, which is an amplifier that controls the laser diode, the radiation of which is input to the main OK through a matching circuit in the form of a segment of multifiber cable.

The receiving part of the OIT equipment consists of the optical receiver (photodiode with postdetector amplifier), the modules for generation of the double cycle frequency VTCh2 and the cycle frequency VTCh1, videorepeater, error detector and reception code converter (1B2B→HDB-3). The VTCh2 module ($2f_T$ = 16.896 megahertz) controls the operation of the videorepeater, and the VTCh1 module (f_T = 8.448 megahertz), the operation of the reception code converter.

The error detector analyzes the structure of the repeated signal and counts the number of disturbances of the 1B2B code structure. Then the signal reaches the input of the BK -- the module for monitoring the state of the OIT equipment. It monitors the fitness of the radiation source, the presence of a signal at the input of the transmitting part of the OIT, not the input of the optical receiver, the presence of errors in the received signal, and the feed voltages. In the case of an emergency with respect to one or several monitored parameters the BK generates an

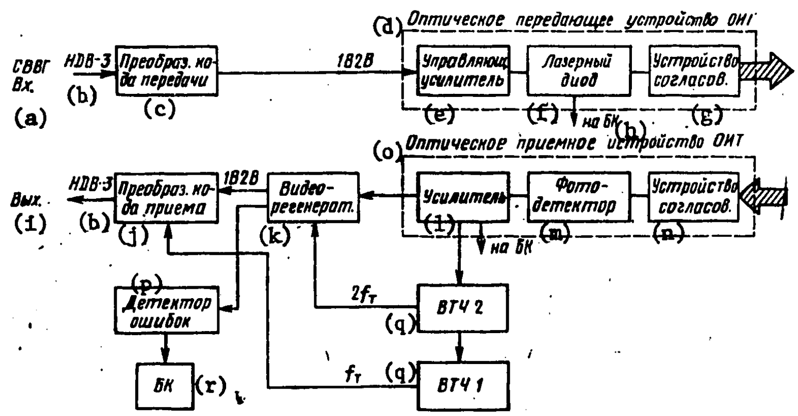

Figure 2.

Key:

a. SVVG input	j. receiving code converter
b. HDB-3	k. videorepeater
c. transmission code converter	l. amplifier
d. optical transmitter of OIT	m. photodetector
e. control amplifer	n. matching circuit
f. laser diode	o. optical receiver of the OIT
g. matching circuit	p. error detector
h. to BK	q. VTCh ...
i. output	r. BK

emergency signal which goes to the general-bay service units, which determine the type and location of the emergency.

The basic parameters of the OIT equipment are as follows:

Transmitter

Radiation source	laser diode
Radiation wavelength	0.85$\pm$0.02 micron
Optical pulse power, input to the fiber	0 dBm
Duration of the optical pulse	30 nanoseconds

Receiver

Photodetector	p-i-n-photodiode
Photodiode sensitivity	0.5 amps/watt
Sensitivity (average optical power)	-42 dBm
Error probability	10^{-9}
Losses to the radiation input to the photodiode	1 decibel
Dynamic range	20 decibels

When using an avalanche photodiode as the photodetector, the sensitivity of the optical receiver increases to -50 dBm.

The terminal equipment of the digital optical remote control channel OAT checks the condition of the information channel equipment at the NRP. The reliability of the transmission in all of the information channels in both directions, the pressure reduction in the NRP container below normal, the fitness of the radiation sources of the transmitters, the operation of the remote control channel itself are monitored.

The transmitting part of the remote control equipment OAT consists of the device that generates digital sounding signals in the necessary sequence and controls the source of the amplifier radiation. The optical output signal is input through the matching circuit to the OK.

The receiving part of the remote control equipment of the OAT consists of the optical receiver including the photodiode and the post-detector amplifier, the remote control signal repeater, the analyzer and display of the state of the information channel and the remote control channel itself.

Basic parameters of the OAT:

Pulse repetition frequency	6.4 kilohertz
Radiation source	laser diode (or light diode)
Radiation wavelength	0.85 micron $\pm$0.02 micron
Optical pulse power input to the fiber	0 dBm
Optical pulse duration	300 nanoseconds

The terminal equipment of the digital optical operator link channel (OAS). In order to obtain a digital signal from the operator link channel, the delta-modulation method is used (see Figure 3). The signal going from the output of the telephone set is converted in the delta coder to a train of pulses with cycle frequency of 32 kilohertz, which is then converted in the transmission signal shaper (FSPer) with respect to duration and levels, after which it goes to the amplifier input controlling the radiation source. In the receiving part detection of the optical signal, amplification, repeating, inverse conversion in the delta coder takes place.

The optical transmitters and receivers of the remote control and operator link systems are identical. The remote control and operator link signals are transmitted over separate paths of monofiber light guides. Hereafter it will be proposed that the remote control and operator link signals be transmitted over one pair of light guides, that is, over a single OTTS channel.

In the described set of equipment provision is made for an operator link also with respect to the remote feed circuits useful in the tuning phase of the equipment on the line.

Structural design of terminal equipment of the line channel. The terminal equipment of the line channel is placed in standard bays 2600 × 600 × 225 mm. Autonomous DP sets, OIT, OAT and OAS equipment, the general bay service equipment, power supply and signal unit for the terminal equipment installed in the SOL bay (see Figure 4). The height of all of the modules in the bay is 225 mm.

The electric cables for the intrabay wiring are laid in the right-hand shaft of the bay, and in the left-hand shaft, the optical monofiber cable wiring joining all of the optical receivers and transmitters to the input device in the upper part of the

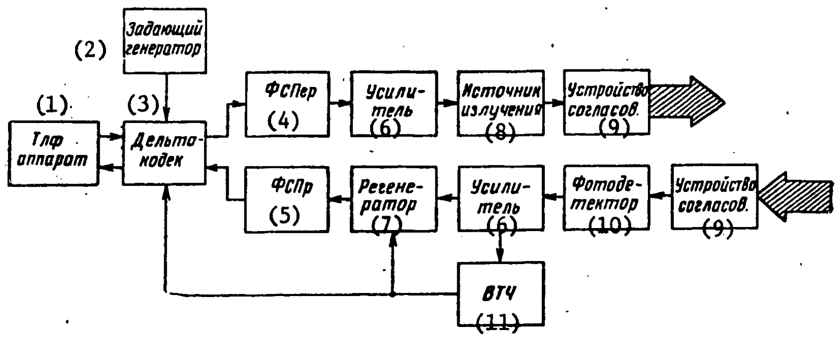

Figure 3.

Key:
1. Telephone
2. master oscillator
3. delta coder
4. FSPer
5. FSPr
6. amplifier
7. repeater
8. radiation source
9. matching circuit
10. photodetector
11. VTCh

Figure 4.

bay. In it the wiring cables are connected through optical plugs either to the optical main cable or to the optical stub cable. The losses in the optical plugs of the input device do not exceed two decibels.

The intermediate equipment of the line optical channel for transmitting the IKM-120 group signal is placed in the NRP of the OKLS, which contains line repeaters of the optical information remote control and operator link signals (RTS), the remote control module (BTK), the remote feed (BP) and protection (BZ) modules.

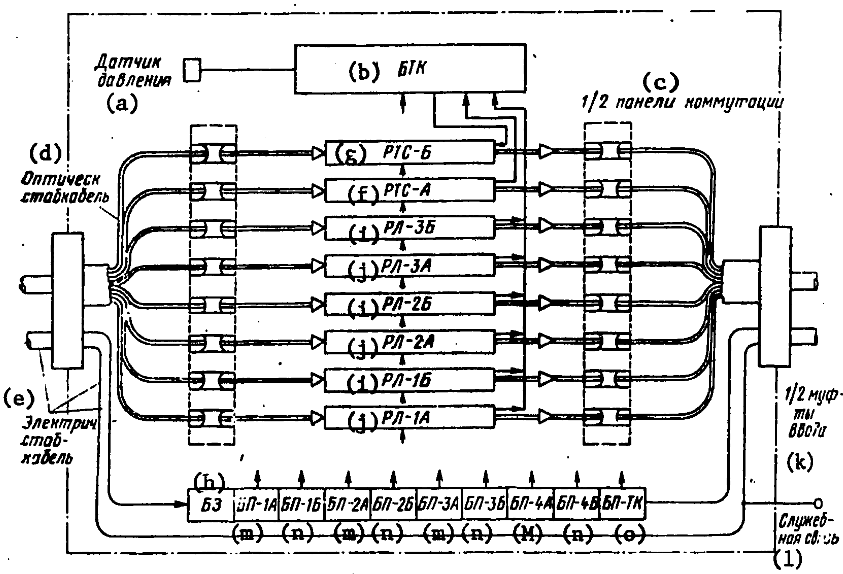

Figure 5.

Key:
- a. pressure gage
- b. BTK
- c. 1/2 of the switching panel
- d. optical stub
- e. electricalstub
- f. RTS-A
- g. RTS-B
- h. BZ
- i. RL-...B
- j. RL-...A
- k. 1/2 of the input coupling
- l. operator link
- m. BP-...A
- n. BP-...B
- o. BP-TK

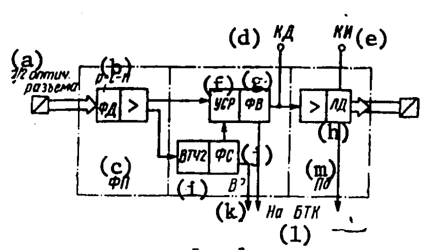

Figure 6.

Key:
- a. 1/2 of the optical plug
- b. p-i-n-photodiode
- c. FP
- d. KD
- e. KI
- f. USR
- g. FV
- h. LD
- i. VTCh2
- j. FS
- k. V2
- l. to the BTK
- m. PB

The NRP was designed for an experimental optical communications line; therefore its structural diagram and the structural design were developed considering that on the one hand, the specific nature of the optical communications is considered as completely as possible, and on the other hand, various circuit and structural versions of the NRP assemblies are tested. Therefore the RL and the RTS are made one way, in the same structure, which permits them to be installed in any direction of any channel; the condition of all the NRP assemblies and remote control signal transmission to the main station are monitored by one BTK module; the DP modules are made separate for each repeater.

The structural diagram of the NRP appears in Figure 5. It consists of six RL, two RTS, one BTK, nine BP, one BZ, the optical signal switching panels and input couplings placed in a container.

The line signal repeater RL (Figure 6) is designed for reproducing the amplitude, the shape and time position of the optical signals of the group flux with cycle frequency of 16.896 megahertz. The RL consists of the photoreceiver (FP) using the p-i-n-photodiode, the videorepeater (VR) containing a synchronous decision circuit (USR), the double cycle frequency generator (VTCh2) using a monolithic quartz filter, the gate pulse shaper (FS) and the reproduced electric signal shaper (FV); an optical transmitter (PD) with laser diode.

The input and output of the optical signals are realized using segments of a monofiber wiring cable which is joined from one side to the photodetector and the emitter and from the other side equipped with optical halfplugs. The signals from the VTCh2 and the URS are fed to the error detector (DO) located in the BTK; the signal from the control unit of the radiator PI also goes to the BTK, and the signals from the output of the URS and from the Pd are sent to the jacks for monitoring the reliability of the KD and the radiator KI.

The line repeater contains a device which permits looping of the RL of the A and B directions with respect to the signal from the BTK.

The basic parameters of the RL are as follows:

Parameters of the input optical signal:

Sensitivity of the receiver (average optical power)	-40 dBm for an error probability of 10^{-9}
Optical pulse duration	40 nanoseconds
Duration of the optical pulse fronts	20 nanoseconds
Radiation wavelength	0.85 micron $\pm$0.02 micron
Dynamic range	20 decibels

Parameters of the output optical signal:

Optical pulse power input to the fiber	0 dBm $\pm$10%
Optical pulse duration	28 nanoseconds$\pm$3 nanoseconds
Duration of optical pulse fronts	10 nanoseconds$\pm$2 nanoseconds
Radiation wavelength	0.85 microns$\pm$0.02 microns
Signals to the BTK	RZ type at the levels of TTL-logic
Power intake from the power supply	1.85 watts

The line repeater of the optical signals RTS (Figure 7) is designed for restoring the amplitude and shape of the optical signals of the remote control and operator link channels. The RTS consists of the photoreceiver (FPT) using the p-i-n-photodiode, the remote control decision circuit (RUT) and the optical transmitter (PdT) with the laser diode (PD) or with the superluminescent light diode.

The RUT includes the decision circuit (UR) and the switching circuit (UK) by means of which the RTS is connected to the BTK and to the operator link system.

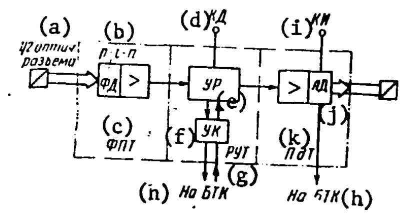

Figure 7.

Key:
a. 1/2 of optical plug
b. p-i-n-photodiode
c. FPT
d. KD
e. UR
f. UK
g. RUT
h. to the BTK
i. KI
j. LD
k. PAT

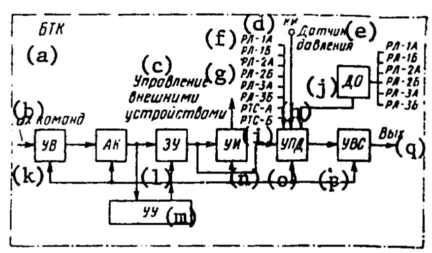

Figure 8.

Key:
a. BTK
b. instruction input
c. external unit control
d. KI
e. pressure gage
f. RL-...A
g. RL-...B
h. RTS-A
i. RTS-B
j. DO
k. UV
l. ZU
m. UU
n. UI
o. UPD
p. UVS
q. output

The basic parameters of the RTS are as follows:

Parameters of the input optical signal:

Sensitivity of the receiver (average optical power) for a signal/noise ratio of 20 decibels	50 dBm

Optical pulse duration	310 nanoseconds ±10%
Pulse repetition frequency	6.4 kilohertz
Radiation wavelength	0.85 micron ± 0.2 micron

Parameters of the output optical signal:

Optical pulse power input to the fiber	0 dBm
Radiation stability	±20%
Optical pulse duration	300 nanoseconds±10%
Radiation wavelength	0.85 micron ±0.02 micron
Signals to the BTK	RZ type in the levels of TTl-logic
Power intake from the power supply	1.5 watts

Figure 9.

Key: a. NRP-VOLS

The BTK remote control unit is designed to check the parameters of the RL, RTS, BP modules and also to monitor the state of the NRP container. The BTK provides for the possibility of remote control of the following: reliability of operation of the repeaters, the radiation power of the laser diodes, the operating quality of the remote control system. It also permits manual and remote looping of the repeaters of directions A and B.

The BTK module (Figure 8) contains the instruction input unit (UV), the instruction analyzer (AK), memory (ZU), data preparation unit (UPD), servoelement (UI), control circuit (UU), the signal input unit (UVS) and error detector (DO).

The basic parameters of the BTK are as follows:

Logical signal level	"1" ... -9 volts "0" ... -0.4 volts
Input signal duration	300 nanoseconds
Duration of one instruction as a function of the measured reliability	1.5 sec; 10.5 sec 101 sec
Repetition frequency	6.4 kilohertz
Power intake from the power supply	200 mwatts

The remote feed modules BP are designed to feed the RL, RTS and BTK -- each assembly has its own module. The remote feed is realized at 220 volts, 50 hertz, AC. All nine BP in the NRP are included in parallel.

The structural design of the NRP developed for the experimental optical communication line (see Figure 9) is designed for installation in large and medium standard corridors of the city telephone exchange and they are designed for operating at an ambient temperature of -40° C to +40° C, relative humidity to 95% at a temperature to 30° C and excess pressure. The installation of NRP in bays and the technical service basements of buildings is permitted.

The location of the RL, RTS and BP modules in the NRP permits replacement of them and other maintenance operations in any direction of any channel without interrupting the operation in the other channels.

The RL and RTS modules have identical overall and installed dimensions, and they are made moisture-proof. The standard module consists of a housing, face panel and holders with plates of functional assemblies insulated and shielded fromeach other. Light guides with optical semiplugs for input and output of optical signals are located in the upper part of the NRP and they are protected by a cover which is removed for connecting the optical halfplugs to the switching panel. On the face panel are the KD and KI monitoring jacks. The remote control feed and signals are connected by plugs in the lower part of the structure.

The BP module is made in the form of a terminal structure providing for heat removal from the stabilizer plates, and it consists of a housing, face panel and supporting structure on which the functional assembly plates are attached. Looping and control microswitches are installed on the face panel along the jacks for monitoring the input and output remote control signals.

The optical signal switching panel is a board on which 16 jacks are arranged in two rows for the optical plugs designed for connecting the optical halfplugs of the repeaters or optical measuring instruments to the optical stub.

The NRP container is made in the form of a cast iron (or aluminum) housing with sealed cover. A valve for supplying air to the container and an operator link plug are located on it. The entry of the optical and electric stub cables to the container is realized by a sealed coupling. Inside the container the optical stub is connected at the bottom to the switching panel, and the electrical stub is connected to the BZ protection module. The NRP is sealed by using a rubber seal.

The weight of the NRP without the stubs and modules is no more than 150 kg. The overall dimensions of the container with the input coupling are 1200 × 560 × 350 mm.

Monitoring and Measuring Instruments. A set of measuring instruments have been developed for adjusting and experimental operation of the OKTsSP. It includes the following:

A digital flow simulator ITsP designed to shape the digital test signals of the 1B2B, HDB-3 code type in the form of a continuously repeating pulse train of 16 arbitrarily selected combinations or a pseudorandom pulse train with a period of $(2^{15} - 1)$;

An error coefficient meter IKO-PSP designed to measure the error coefficient of the line channel with interruption of communications. The estimate is made by the test signals from the ITsP (for measurements along the line) or by the same test signals shaped by the IKO-PSP (for measurements on the loop). The limits of the error measurement are from 10^{-2} to 10^{-12};

The portable error coefficient meter IKO-SP designed for estimating the error coefficient on the line channel repeaters without interrupting communications in the type 1B2B code. The limits of the estimate are from 10^{-5} to 10^{-8}. The error coefficient is determined by the 1B2B code. The instrument power comes from storage batteries installed in its housing;

A test unit designed for adjusting and testing line repeaters. It operates jointly with ITsP or the IKO-PSP, it contains an error detector, an error coefficient meter, a shaper of errors of various type introduced into the test signal, an optical attenuator, an optical power display, a simulator of the test signal phase jitter, the measuring optical receiver; a meter for measuring the signal attenuation in the optical cable.

Conclusion. The described OKTsSP equipment was subjected to two-way laboratory testing; then it was installed and tested under field conditions, on the experimental line of the city telephone exchange between two automatic offices. The tests confirmed the fitness of the entire system as a whole, and correspondence of the achieved parameters to the given technical specifications.

The results of testing the system will be taken into account during further developments of optical digital information transmission systems.

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INSTRUMENTS, MEASURING DEVICES
AND TESTERS, METHODS OF MEASURING,
GENERAL EXPERIMENTAL TECHNIQUES

UDC 621.317.757

HIGHLY SENSITIVE LOW-FREQUENCY SPECTRUM ANALYZER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, 1980 pp 94-95 manuscript received 11 Jul 78

[Article by G. P. Zhigal'skiy and Yu. A. Tyurin, Moscow Institute of Electronic Engineering]

[Text] The paper describes a highly sensitive low-frequency spectrum analyzer with sensitivity of 10^{-19} V^2/Hz based on transistors and integrated circuits. Width of passband 0.2 Hz, frequency range of analyzable signals 2-500 Hz.

This spectral analyzer, based on a superheterodyne receiver circuit, is intended for measuring a spectrum in the range of low and infralow frequencies. A block diagram of the analyzer with preamplifier is shown in Fig. 1, and a schematic diagram is shown in Fig. 2. The selective system of the analyzer is tuned to an intermediate frequency of 263 Hz. The components of the signal spectrum are measured as the heterodyne is gradually tuned. The latter is a G3-39 low-frequency oscillator.

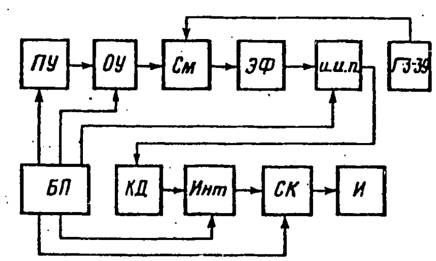

Fig. 1. Block diagram of spectrum analyzer. *ПУ*--preamplifier; *ОУ*--main amplifier; *См*--mixer; *ЭФ*--electromechanical filter; *и.и.п.*--conductivity inverter with current inversion; *Г3-39*--low-frequency oscillator; *БП*--power supply; *КД*--square-law detector; *Инт*--integrator; *СК*--compensation circuit; *И*--display

When studying the spectrum of signals with a low noise level, the analyzer works with a cooled preamplifier. This amplifier is based on FETs T_1-T_5, and is made as a separate module. The internal noises of the amplifier are reduced first of all by connecting the transistors in parallel [Ref. 1]. In addition, the set noise of the amplifier is reduced by using nitrogen vapor to cool it to 77 K. To minimize noise, the bias voltage across the gate is zero, while the voltage across the drain is 2.1 V [Ref. 2]. The amplifier has a passband of 0.3-10^5 Hz, gain of 30 and input impedance of 5 MΩ. The first stage of the amplifier is supplied by a separate source. Fig. 3 shows the frequency dependence of the equivalent noise impedance of the preamplifier normalized to the input.

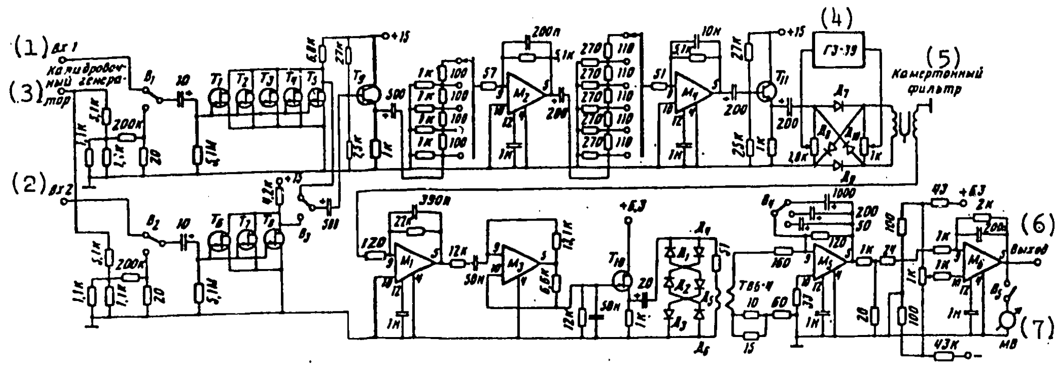

Fig. 2. Schematic diagram of spectrum analyzer. M_1-M_6--1UT401A; T_1-T_8--2P303A; T_9, T_{11}--KT315A; T_{10}--2P302A; $Д_1$-$Д_6$--D809; $Д_7$-$Д_{10}$--2D510A; 1--first input; 2--second input; 3--calibrating oscillator; 4--low-frequency oscillator; 5--tuning-fork filter; 6--output; 7--millivoltmeter

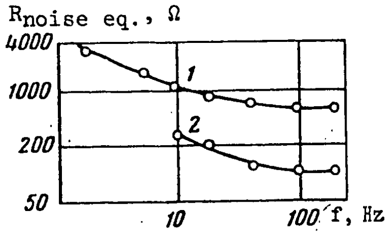

Fig. 3. Frequency dependence of equivalent noise impedance of preamplifier: 1--T = 300 K; 2--77 K

When studying signals with an elevated noise level ($\geqslant 10^{-17}$ V^2/Hz) the cooled preamplifier can be disconnected by switch B_3 and replaced by a preamplifier based on transistors T_6-T_8. The main amplifier based on low-noise integrated circuits M_2, M_4 has gain $\geqslant 10^4$ when the feedbacks are activated. To prevent overload, the frequency response has a steep drop on a frequency of 800 Hz, which is realized by selection of the elements in the feedback circuit of microcircuit M_4.

The selective system of the analyzer consists of a mixer, a tuning-fork filter and an active filter. The balanced ring mixer is based on 2D510A diodes, which are selected with identical current-voltage characteristics to suppress signals of the heterodyne and the intermediate frequency. The optimum heterodyne voltage at which the transfer constant of the mixer is maximum is 6 V; signal suppression of the heterodyne and intermediate frequency in this case is about 70 dB. A tuning-fork filter is used as the intermediate-frequency filter. Waveforms are excited and coupled out by electromagnets with magnetized cores. The resonant frequency of this filter is 263 Hz, the equivalent Q is about 1300, $\Delta f(-3\text{ dB}) = 0.2$ Hz; $\Delta f(-20\text{ dB}) = 2$ Hz. The electromagnetic coils of the tuning-fork filter are carefully shielded from external pickups.

To increase selectivity and extend the amplification of the output signal, a selective active filter is used that is based on a conductivity inverter with current inversion (*u.u.n.* in Fig. 1) [Ref. 3]. This circuit, in contrast to the selective amplifier based on the double T-bridge, does not require matching of passive components and is more stable in operation. Opamp M_3 is used as the active element. A source-follower based on transistor T_{10} matches the *u.u.n.* to the next stage. The active filter based on the *u.u.n.* has the following characteristics: resonant frequency 263 Hz, $\Delta f(-3\text{ dB}) \approx 2.5$ Hz, gain 40 dB.

The square-law detector is a TVB-4 thermal converter with rated current of 10 mA, but in the given circuit the TVB-4 operates in the underloaded mode at a current of 2.5 mA. The thermal converter is protected from overloads by a circuit based on silicon stabistors $Д_1$-$Д_6$. A pseudo-integrator based on microcircuit M_5 [Ref. 4] is used to amplify the d-c signal component and smooth out pulsation. At integrator time constants of 120, 20 and 5 s, noise is measured with an error of 10, 25 and 50% respectively. An integration time of 5 s is used in estimating noise measurements, enabling on-the-spot setting of the required amplification range. The main purpose of the circuit based on chip M_6 is to compensate for internal noises of the spectral analyzer and thermal noises of the studied structures, which appreciably facilitates the process of noise measurement in the form 1/f, and enables measurement of noises with a level below the inherent noises of the spectrum analyzer by ≈20 dB. By working with compensation, the sensitivity of the spectrum analyzer is brought up to 10^{-19} V^2/Hz. The spectrum analyzer is made in the form of two modules: the analyzer proper and a power supply with stabilization circuit. The analyzer stages are made in the form of separate subassemblies, enabling effective shielding from external interference. The analyzer can be operated with any other preamplifier. Any scale-of-ten low-frequency oscillator can be used as the heterodyne.

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UDC 621.396.969.1

PRINCIPLES OF THE CLASSIFICATION OF NAVIGATIONAL SYSTEMS OF SECONDARY RADIO DETECTION AND RANGING AND THE INFLUENCE OF INTERFERENCE FADINGS ON THEIR OPERATION

[Abstract of article by Chernyayev, R. N.]

[Text] The author discusses the application areas of systems of secondary radio detection and ranging in navigation, principles of their classification, and means of their technical realization. He analyzes the influence of the interference of radio waves caused by reflections from the surface of the sea on the changes in the intensity of signals and variations in the delays of response signals.

Figures -- 3, table -- 1, bibliography -- 3 items.

UDC 621.396.96.01

THE USE OF THE IMPORTANCE SAMPLE METHOD IN CALCULATING THE CHARACTERISTICS OF THE DETECTION OF FLUCTUATING SIGNALS AGAINST THE BACKGROUND OF CORRELATED INTERFERENCE

[Abstract of article by Komissarov, G. F.]

[Text] The author examines the application of the importance sample method in evaluating the effectiveness of the algorithms of the detection of radio detection of radar signals against the background of correlated interference. He gives the characteristics of the detection of fluctuating signals against the background of the Markov-Raleigh interference for two detection algorithms.

Figures -- 3, bibliography -- 4 items.

UDC 621.396.96.01.019.3

EXPERIMENTAL STUDIES ON THE RELIABILITY OF THE RESOLUTION OF RADAR SIGNALS

[Abstract of article by Demin, I. D.]

[Text] The author examines the results of experimental studies on the dependence of the resolution parameters of ship's radar stations (RLS) on the reliability of separate observations of signals under natural conditions. He gives recommendations for selecting a probable criteria for the evaluation of the reliability of the resolution of radar signals for operational measurements of the resolving power and minimal operation range of ship's RLS.

Figures -- 3, table -- 1, bibliography -- 7 items.

UDC 621.396.931:527.8.01

A SIMPLIFIED ALGORITHM FOR CALCULATING REGULAR PHASE SHIFTS ON THE FUNDAMENTAL FREQUENCY FOR "Omega" RNS [Radio Navigation System]

[Abstract of article by Volodin, V. I.]

[Text] The author examines the possibility of obtaining a simplified algorithm for calculating RFS [regular phase shifts] with the use of approximate expressions for the phase velocity of propagation of SDV.

Figures -- 4, tables -- 2, bibliography -- 7 items.

UDC 621.396.931:527.8.01

IDENTIFICATION OF SIGNALS AND SELECTION OF STATIONS FOR DETERMINATION BY "Omega" RNS

[Abstract of article by Bykov, V. I., Kozharskiy, R. G., Khotyakov, S. Ya., and Shilenkov, M. F.]

[Text] The authors examined the possibilities of the synchronization of receiving indicators of the "Omega" RNS and geometrical factors of the system connected with the accuracy of the determination of location.

Figures -- 3, bibliography -- 2 items.

UDC 629.12.072+629.12.053.2

MEASURING THE SPEED OF VESSELS IN ICE NAVIGATION

[Abstract of article by Shamkin, L. A.]

[Text] The author examines the basic shortcomings of the existing methods of measuring the speed of a vessel in ice based on the measurement of the base it covers. He makes suggestions for considering the errors from changing the course during the measurements for the woodrail log and inertia in the computation by the rotations of the propeller, and proposes a method of determining the speed by traverse bearings and distances with the aid of an RLS [radar station]. A possible solution of the problem of measuring the speed in ice is examined.

Figure -- 1, table -- 1, bibliography -- 6 items.

UDC 629.12.053.1

EFFECTS OF THE POSITION OF THE GYROCOMPASS ON THE ERROR IN THE DETERMINATION OF THE SHIP'S COURSE

[Abstract of article by Filin, V. M.]

[Text] The author determined the linear and angular velocities and accelerations acting on an indirect-control gyrocompass being corrected which is installed at a considerable distance from the center of gravity of a large-capacity vessel.

The author evaluates compass errors due to additional detected constant and variable components of speed, as well as additional accelerations affecting the unbalance of the gyrochamber, the horizon indicator, and the pendulum of the gyrounit. He shows the possibility of using compasses with a larger natural period on the bridges of inertial vessels with an insignificantly lower accuracy of course indication.

Figure -- 1, Tables -- 2, bibliography -- 3 items.

UDC 629.12.053.11

ERRORS OF MAGNETIC COMPASSES CAUSED BY THE ROTARY MOTION OF THE HULL IN A MAGNETIC FIELD

[Abstract of article by Sigachev, N. I.]

[Text] The author discusses the problems of the accuracy of indications of magnetic compasses and depth measurements with the aid of a magnetic field.

Figures -- 5, table -- 1.

UDC 621.12.014.6-52

AUTOPILOT IN THE CONTROL SYSTEM OF A VESSEL ON A PRESCRIBED TRAJECTORY

[Abstract of article by Antonenko, V. A., and Mirenskiy, M. G.]

[Text] The authors discuss special characteristics and advantages of using an autopilot in the control system of a vessel on a trajectory of the communication device IVK-steering machine.

Figure -- 1.

UDC 629.12.053.2

ERROR OF THE INDUCTION LOG IEL-2 FROM THE QUADRATURE COMPONENT OF THE SIGNAL AND A METHOD OF ITS COMPENSATION

[Abstract of article by Belov, Yu. I.]

[Text] The author examines the error of the induction log IEL-2 which changes in the course of time and gives recommendations for its reduction.

Figures -- 4.

UDC 656.615.021.8:31

STATISTICAL CHARACTERISTICS OF SHIP TRAFFIC AND THE TIME OF RADAR GUIDANCE OF SHIPS

[Abstract of article by Lentarev, A. A.]

[Text] The author examines the characteristics of ship traffic in ports from the positions of statistical analysis.

Figures -- 4, table -- 1, bibliography -- 3 items.

UDC 656.615.021.8

INVESTIGATION OF THE REGULARITIES OF THE FORMATION OF STREAMS OF SHIP TRAFFIC

[Abstract of article by Zubarev, V. L.]

[Text] The author presents the results of his studies on the regularities in the formation of streams of ship traffic: distribution of the number of passing vessels; distribution of the time intervals between the arrivals of vessels. He concludes that in most instances the type of the distribution law of the studied values is the same, but the distinctive features of its manifestation in individual instances usually consists in the differences of the values of the parameters.

Bibliography -- 2 items.

UDC 629.783+656.61.052.14:527.62

DETERMINATION OF THE POSITION OF A SHIP AND ITS DISTANCE TO THE SATELLITE BY THE SHIP'S SATELLITE COMMUNICATION STATION

[Abstract of article by Zhilin, V. A.]

[Text] The author gives simple algorithms for determining the position of a vessel and the distance to a geostationary satellite with the aid of a directional antenna of the ship's satellite communication station. He shows that the accuracy of the determination of these data is sufficient for solving certain problems which are of interest for the organization of communication via satellites.

Figures -- 3.

UDC 629.783+656.61.087/.088

DETERMINATION OF THE REQUIRED NUMBER OF NONSYNCHRONOUS ARTIFICIAL EARTH SATELLITES IN THE INTERNATIONAL SATELLITE DISTRESS SERVICE

[Abstract of article by Bronitskiy, I. S.]

[Text] The author examines the problem of determining the number of artificial earth satellites required for immediate (with a prescribed probability) access to the communication channels of the International Satellite Distress Service. The obtained results can be used also in developing other information transmission systems with immediate access using nonsynchronous artificial earth satellites.

Figures -- 2, bibliography -- 2 items.

UDC 621.391.82

THE WIDTH OF THE SPECTRUM OF INTERFERENCE OF INTERMODULATION AND THE NECESSARY BAND OF OPERATING FREQUENCIES FREE FROM THIS INTERFERENCE

[Abstract of article by Bibichkova, R. P.]

[Text] The author determines the width of the frequency band occupied by all components of the interference of intermodulation of the third, fifth, and seventh orders. The results can be used for communication systems with the frequency division of channels.

The article gives the results of calculations of the sequences of operating channels free from the most intensive types of interference (third and fifth orders).

Figure -- 1, table -- 1, bibliography -- 7 items.

UDC 621.391.837

SUPPRESSION OF SELECTIVE INTERFERENCE IN WIDEBAND COMMUNICATION SYSTEMS

[Abstract of article by Dolgochub, V. T., and Demidenko, P. P.]

[Text] The authors examine the possibility of suppressing selective interference in wideband communication systems. They analyzed four methods of suppressing selective interference in wideband communication systems. They give formulas of gain for each case and a block diagram.

Figure -- 1.

UDC 621.396.62

EFFECTIVE SELECTIVITY OF RADIO-RECEIVING DEVICES AND ITS INFLUENCE ON THE RELIABILITY OF SHORTWAVE COMMUNICATION

[Abstract of article by Li Za Son]

[Text] The author examines the problems connected with the determination of the parameters characterizing the effective selectivity of radio-receiving devices. He establishes the relation between the effective selectivity of radio-receiving devices and the reliability of shortwave communication.

Figures -- 2, table -- 1, bibliography -- 3 items.

UDC 621.391.837

NOISE IMMUNITY OF THE RECEPTION OF WIDEBAND SIGNALS IN THE PRESENCE OF CONCENTRATED INTERFERENCE

[Abstract of article by Venskauskas, K. K., Garbuzov, I. Z., and Golubkov, G. D.]

[Text] The authors determine the effects of the rejection of individual sections of the spectrum of three types of wideband signals affected by concentrated interference. They obtained tables for calculating noise stability of optimal incoherent reception and plotted error probability curves for various combinations of connecting rejection filters.

Figure -- 1, tables -- 2, bibliography -- 2 items.

UDC 621.7.8

EVALUATION OF THE EFFECTIVENESS OF USING NEW TECHNICAL SOLUTIONS IN SHORTWAVE CHANNELS OF MARITIME RADIO COMMUNICATION

[Abstract of article by Zudov, A. S., and Sheverdyayev, V. N.]

[Text] The authors give special characteristics of the method of experimental determination of the characteristics of shortwave channels of maritime radio communication.

On the basis of the obtained experimental data, they propose a method of objective evaluation of the effectiveness of using new technical solutions in shortwave channels of maritime radio communication.

Figures -- 2, table -- 1, bibliography -- 2 items.

UDC 621.396.24

SUPPRESSION OF PULSED INTERFERENCE BY THE METHOD OF INTERRUPTING THE RECEIVING CHANNEL IN APPLICATION TO MARITIME SHORTWAVE RADIO COMMUNICATION

[Abstract of article by Cherkasskiy, Yu. A., and Malakhov, L. M.]

[Text] The authors examined the problems of controlling the relatively rare atmospheric radio interference by the method of interrupting the intermediate-frequency channel of the radio-receiving device in maritime channels of discrete shortwave radio communication. They used a semiempirical method of approximate evaluation of noise immunity in the reception of frequency-modulated signals in the presence of atmospheric radio interference. It is shown that the interruption of the channel for the action time of the relatively rare and strong interference can reduce the average probability of reception errors by approximately one order.

Figure -- 1, bibliography -- 6 items.

[170-10,233]

10,233
CSO: 1860

ADDITIONAL ABSTRACTS OF ARTICLES ON NAVIGATION AND COMMUNICATIONS

Leningrad TRUDY TSENTRAL'NOGO NAUCHNO-ISSLEDOVATEL'SKOGO INSTITUTA MORSKOGO FLOTA: SUDOVOZHDENIYE I SVYAZ' in Russian No 245, 1979 (signed to press 1 Jun 79) pp 118-121

[Abstracts of articles from "Transactions of the Central Scientific Research Institute of the Maritime Fleet: Navigation and Communications" No 245, Leningrad, "Transport", 2279 copies]

UDC 656.61.052.484

DETERMINATION OF THE NUMBER OF TARGETS PROCESSED SIMULTANEOUSLY BY THE COLLISION PREVENTION SYSTEM

[Abstract of article by Likhachev, A. V.]

[Text] The author discusses a method for determining the optimal number of simultaneously processed targets in the collision prevention system.

Figures -- 2, bibliography -- 5 items.

UDC 621.396.967:629.12

EVALUATION OF ELECTROMAGNETIC COMPATIBILITY BY THE METHOD OF DIGITAL SIMULATION

[Abstract of article by Rzhevtsev, Yu. V.]

[Text] The article describes an algorithm developed by the author for determining the level of interstation interference for practically any number of interacting radar stations.

Figures-- 2, bibliography -- 3 items.

UDC 621.396.932.1

ON CALCULATING THE FUNCTIONING EFFECTIVENESS OF MAINTENANCE BASES

[Abstract of article by Kolmogorov, I. P]

[Text] The author gives a method for calculating the functioning effectiveness of maintenance bases based on the theory of mass maintenance. For an organizational unit which is determining for a given type of electroradionavagation equipment, the author took a production section with its characteristic parameters and economic indexes. An example of calculating the functioning effectiveness of a ship maintenance base is given.

Tables -- 3.

UDC 629.12.053.13

THREE-STAGE TORSION SUSPENSION FOR THE GYROCOMPASS

[Abstract of article by Sigachev, N. I.]

[Text] The article discusses a special torsion suspension ensuring three degrees of freedom for the sensitive element of the gyrocompass.

Figures -- 1, bibliography -- 4 items.

UDC 656.61.08:31

SHIPWRECK DYNAMICS OF THE WORLD FLEET UNDER STORM CONDITIONS

[Abstract of article by Danilyuk, M. I.]

[Text] The author gives the statistics of the shipwrecks of the world fleet for 1962-1976.

Figures -- 1.

UDC 629.12.053

POSSIBILITIES OF USING LASER RANGE FINDERS AND SPEEDOMETERS IN NAVIGATION

[Abstract of article by Ignatovich, E. I.]

[Text] The author examines the possibilities of using laser range finders and speedometers in navigation.

Tables -- 1, bibliography -- 2 items.

UDC 656.61.052.484:621.396.969.3

SAFE DISTANCES BETWEEN VESSELS WHEN THEY MOVE ALONG THE NAVIGATION CHANNEL AND THEIR USE IN AUTOMATED RDS [AREA TRAFFIC CONTROL SERVICE] SYSTEMS

[Abstract of article by Zubarev, V. L.]

[Text] A method is offered for calculating safe distances when a ship moves along the channel and passes a ship moving in the opposite direction which reflects the physical essence of the interaction process of the vessels and is convenient for analysis and use in regulation algorithms. The author investigates the obtained relationships.

Figures -- 3, table -- 1, bibliography -- 5 items.

UDC 656.61.052.484.001.57

SIMULATION OF THE MOVEMENT OF VESSELS ALONG THE CHANNEL

[Abstract of article by Lentarev, A. A., and Zhivotok, V. N.]

[Text] The authors examine a program for simulating the simplest variant of the system -- a linear channel, and give the results of solving some specific problems.

Figures -- 3, bibliography -- 3 items.

UDC 656.61.052.484

PROBABILITY OF DANGEROUS APPROACH OF VESSELS

[Abstract of article by Taratynov, V. P.]

[Text] The article describes the possibility of using the probability of dangerous approach in streams of vessels moving in opposite direction as a basis for the evaluation criteria for traffic control systems. Basic formulas for the evaluation of dangerous approach are derived.

Figures -- 4, bibliography -- 3 items.

UDC 629.12.053.13

SOME PROBLEMS OF THE THEORY OF A SINGLE-ROTOR ADJUSTABLE GYROCOMPASS WITH CONTROLLED SPEED OF THE DEFLECTION OF THE SENSITIVE ELEMENT FROM THE PLANE OF THE HORIZON

[Abstract of article by Mitnik, V. M.]

[Text] The article contains studies pertaining to the theory of a single-rotor gyrocompass with a liquid, torsional suspension of the sensitive element in which the damping of the natural oscillations is achieved by the superposition on the horizontal axis of the suspension of a moment proportional to the speed of the deflection of the main axis of the gyroscope from the plane of the horizon.

Figures -- 1, bibliography -- 5 items.

UDC 656.61.052.14:527.62

THE ISOLINE ON THE SPHERE IN THE INTEGRAL DOPPLER METHOD FOR DETERMINING THE POSITION OF A VESSEL BY NISZ (expansion unknown)

[Abstract of article by Kozhukhov, V. P.]

[Text] The author gives a simple derivation of the equation of an isoline on the spherical surface for a case when the position of the vessel if determined according to NISZ by the integral Doppler method. The difference between this isoline and a spherical hyperbola is noted.

Figure -- 1.

UDC 629.12.053.2

SPECIAL CHARACTERISTICS OF THE USE OF THE DOPPLER HYDROACOUSTIC LOG DURING ICE NAVIGATION

[Abstract of article by Shamkin, L. A.]

[Text] The author discusses the determination of the drift angle of a vessel in motion during ice drift and method of eliminating the error in measuring the traverse velocity of drift from the wind and the current during asymmetric yawing or changing of the course.

Figures -- 3.

UDC 621.396.676:629.12

BASIC REGULARITIES IN THE INFLUENCE OF METALLIC STRUCTURES ON THE CHARACTERISTICS OF SHIP'S ANTENNAS

[Abstract of article by Vershkov, M. V.]

[Text] The author analyzes the conditions of the influence of ship's metallic structures on the characteristics of the antennas, determines the basic regularities of this influence, and gives recommendations for arranging the antennas on the ship.

Figures -- 7, bibliography -- 6 items.

UDC 621.396.932

ON DIGITAL NUMERATION OF STATIONS OF THE MARITIME MOBILE SERVICE

[Abstract of article by Zudov, A. S, Kazanskiy, S. S., Chernov, A. G., and Shavykin, V. A.]

[Text] The authors examine operational aspects of the general numeration system of the maritime mobile (MPS) and maritime mobile satellite (MPSS) services. On the basis of the analysis of the methods of access to ship stations from land subscribers through distribution boards of local, national, and international networks of general use, they formulated the requirements for a station numeration system and proposed a format and a two-step procedure for establishing connections with vessels when it is used.

Tables -- 2, bibliography -- 6 items.

UDC 621.396.676

SOLUTION OF A SYSTEM OF INTEGRAL EQUATIONS FOR A BROAD-BAND MULTIDIPOLE ANTENNA

[Abstract of article by Mikhaylov, S. N.]

[Text] The author proposes a rigorous approach on the basis of a system of connected integral equations to the establishment of the distribution of current along a broad-band multidipole antenna and subsequent establishment of its parameters: Z_{input}, directional pattern, directive gain.

Figures -- 2, bibliography -- 7 items.

UDC 621.396.932

STATISTICAL CHARACTERISTICS OF THE LOADING AND THE SELECTION OF TsPR [central port radio station] CHANNELS OF THE SYSTEM OF MARITIME ULTRASHORT-WAVE COMMUNICATION

[Abstract of article by Li Za Son, Nazarova, I. N., and Sokolov, B. P.]

[Text] This article gives the results of statistical studies on the loading of radio telephone channels. On the basis of the analysis of the studies, the necessary number of channels for central port stations is determined.

Figure -- 1, table -- 1.

UDC 621.396.932.09

RESULTS OF STUDIES ON ADAPTIVE ANALOG-DIGITAL MODEMS IN REAL RADIO COMMUNICATION CHANNELS

[Abstract of article by Arzumanyan, Yu. V., Zakharov, A. A., Gavrilov, V. I., Li Za Son, Naumov, A. S., Sokolov, B. P., and Fomin, Yu. P.]

[Text] The article gives the results of studies on adaptive analog-digital modems in real radio communication channels.

Figure -- 1, bibliography -- 4 items.

UDC 621.391.8

RECEPTION OF SIGNALS AGAINST THE BACKGROUND OF SPECTRUM-CONCENTRATED INTERFERENCE IN SLOWLY FADING CHANNELS

[Abstract of article by Venskauskas, K. K., Cherkasskiy, Yu. A., and Mel'tser, A. Z.]

[Text] The authors examine a case of doubled transmission of frequency-modulated signals in the system of maritime shortwave radio communication and reception with automatic selection of the conditions of addition or reception through one of the channels under the conditions of the effect of concentrated interference. The authors propose a device for classifying the condition of the channels which controls the automatic selection circuit. It is shown that the use of the proposed classifier ensures a noticeable gain in noise stability in comparison with the addition mode.

Figures -- 3, table -- 1, bibliography -- 3 items.

UDC 656.61.052.14:527.62

CALCULATION OF THE PARAMETERS OF THE ELLIPSE OF ERRORS IN DETERMINING THE POSITION OF AN OBJECT WITH THE AID OF ARTIFICIAL EARTH SATELLITES ON THE BASIS OF REDUNDANT, CORRELATIONALLY CONNECTED RANGE MEASUREMENTS

[Abstract of article by Karpov, M. V., and Lebedeva, V. M.]

[Text] The authors investigate the accuracy of the determination of the position of an object with the aid of a satellite range-finding navigation system in the presence of redundant, correlationally connected measurements. They examine a case of an arbitrary number of discrete correlationally dependent range measurements. They derive the basic analytical relations for calculating the elements of the ellipse of errors in determining the position of an object for various values of the parameters which characterize the mutual arrangement of the object and the location points of the satellite at the moments of measurements.

The obtained formulas are used for calculations and compilation of the charts of the dependence of the elements of the ellipses of errors on the above parameters.

Figures -- 5, bibliography -- 2 items.

UDC 621.391.8

EFFECTS OF LATERAL OVERSHOOTS OF APERIODIC CORRELATION FUNCTIONS OF NOISE-LIKE SIGNALS ON THEIR DETECTION WITH THE AID OF DISCRETE MATCHED FILTERS

[Abstract of article by Stepanenko, D. P.]

[Text] The author gives the results of his studies on the probability of exceeding a prescribed threshold by the overshoots of aperiodic correlation functions of noise-like signals (ShPS) due to errors in the discrimination of the elements of ShPS in the processing of such signals by discrete matched filters (DSF).

Figure -- 1.

[171-10,233]

10,233
CSO: 1860

UDC 629.7.058.54.004(075.3)

AIRCRAFT RADAR EQUIPMENT AND ITS OPERATION

Moscow RADIOLOKATSIONNOYE OBORUDOVANIYE SAMOLETOV I YEGO EKSPLUATATSIYA in Russian 1980 (signed to press 5 Mar 80) pp 2, 244-245

[Annotation and table of contents from book "Aircraft Radar Equipment and Its Operation", by Anatoliy Pavlovich Tikhonov, Izdatel'stvo "Transport", 7000 copies, 248 pages]

[Text] The basic design principles and circuitry of three types of aircraft radars are presented in the book: doppler drift and velocity radars , the radar transponder of the air traffic control system, and panoramic radar. The physical meaning of the navigational concepts and definitions to which radar functions are related is revealed in the theoretical substantiation of the structure of radars.

The bulk of the books contents is devoted to a description of the functional schemes and circuit design of the most promising specific devices: the DISS-013 doppler meter, the COM-64 aircraft transponder of the air traffic control system, and the "Groza-154" panoramic radar.

The book is intended as a textbook for students of the technical aviation schools of civilian aviation as well as students of technical servicing schools. It can also be useful to the engineering and technical staff of the production subdivisions and students of the radio engineering departments of higher educational institutes specializing in the field of the technical operation of aircraft radio equipment.

Table of Contents

[137-8225]

8225
CSO: 1860

APPLICATION OF THE MARKOV THEORY OF NONLINEAR FILTERING IN RADIO ENGINEERING

Moscow PRIMENENIYE MARKOVSKOY TEORII NELINEYNOY FIL'TRATSII V RADIOTEKHNIKE in Russian 1980 (signed to press 10 Jul 80) pp 2, 356-358

[Annotation and table of contents from book "Application of the Markov Theory of Nonlinear Filtering in Radio Engineering", by Mikhail Semenovich Yarlykov, Izdatel'stvo "Sovetskoye radio", 4500 copies, 360 pages]

[Text] Modern methods of the Markov theory of optimal nonlinear filtering are discussed and generalized, making it possible to solve problems in the synthesis of receivers and processing equipment for a very large and promising class of radio signals. Much attention is paid to various applications of methods of the Markov theory of optimal nonlinear filtering for solving applied science problems. Based on an analysis of real operating conditions of radio navigation, radio communications, radar and radiotelemetry systems, according to a unified developed procedure is solved a great number of specific radio engineering problems of independent theoretical and practical importance. In each case optimal structural diagrams are obtained for receivers and signal processing equipment of systems, their parameters are determined and quality characteristics are calculated.

Intended for scientific personnel and engineers involved in developing, producing and studying radio engineering data transmission systems. Useful to graduate students and students.

CONTENTS

[169-8831]

8831
CSO: 1860

AUTOMATED DESIGN OF MICROWAVE DIRECTIONAL COUPLERS

Moscow AVTOMATIZIROVANNOYE PROYEKTIROVANIYE NAPRAVLENNYKH OTVETVITELEY SVCH in Russian 1980 (signed to press 2 Jun 80) pp 2, 144

[Annotation and table of contents from book "Automated Design of Microwave Directional Couplers", by Valeriy Petrovich Meshchanov and Aleksandr L'vovich Fel'dshteyn, Izdatel'stvo "Svyaz'", 2350 copies, 144 pages]

[Text] The theory is discussed and the software is presented for the automated design of wideband and ultrawideband directional couplers implemented with microstrips and waveguides. The results of the optimization of NO's [directional couplers] having a practical application are presented in the form of tables. The fundamentals of the computer optimization of microwave elements are discussed. Programs for the automated design of NO's employing coupled lines, etc., are developed. Programs are presented for the synthesis of microstrips with a complicated configuration of the cross section of coupled internal conductors.

Intended for engineering and technical personnel and specialists in computer-assisted design.

CONTENTS Page

[164-8831]

8831
CSO: 1860

UDC 621.396.969

MULTICHANNEL RADAR MEASURING EQUIPMENT

Moscow MNOGOKANAL'NYYE RADIOLOKATSIONNYYE IZMERITELI in Russian 1980 (signed to press 21 May 80) pp 2-5, 189-190

[Annotation, foreword and table of contents from book "Multichannel Radar Measuring Equipment", by Nikolay Matveyevich Tsar'kov, Izdatel'stvo "Sovetskoye radio", 4000 copies, 190 pages]

[Text] The principles of signal processing in multichannel radar measuring devices and methods based on deterministic and statistical approaches for evaluating the accuracy and resolution under interference conditions are examined Much attention is devoted to angular coordinate measuring devices, including a single-pulse type. Examples of the synthesis of optimal and quasioptimal measuring devices, as well as calculation of measurement error when exposed to various types of interference are presented.

The book is intended for scientific workers, graduate students and radio network design engineers.

Figures 68; tables 2; references: 83.

FOREWORD

One of the urgent problems of modern radar is the measurement of parameters and radio signals simultaneously arriving from several single objects. The greater the number of measurements, the more effectively the radar unit fulfills its task.

One of the trends in the improvement of radar devices is the shift to a multichannel design principle, which permits their capability to be expanded significantly when taking measurements under complex radar and electromagnetic conditions. This principle is already being broadly realized using phased antenna arrays, computer technology, and acoustooptical and holographic means for signal processing. It is for just this reason that an increased interest in multichannel radar measuring devices arose and numerous publications on problems of their analysis and synthesis have appeared.

The work of a collective of authors under the editorship of G. P. Tartakovskiy [2], in which questions of the synthesis and analysis of measuring devices with high resolution are examined in an extremely generalized form, was the first and most highly systematized work on the statistical theory of multichannel measuring devices. Questions of signal resolution in multichannel measuring devices are correlated adequately broadly in Ya. D. Shirman's book [57]. A number of works have been devoted to concrete circuits for multichannel measuring devices which use angular coordinates [63, 64, 70, 74, 75] and to individual aspects of the theory [68, 71, 76]. Both deterministic and statistical approaches to solving the problems of analysis and synthesis are used in the preceding works; applied aspects of the theory are worked out as applicable to particular instances of signal processing, and questions of the realizability of the synthesized circuitry frequently remain in the general theoretical works.

In the present book, the general design regularities of such measuring devices are identified based on generalizations of certain results of the theory and practice of analysis and synthesis of multichannel measuring devices, and their potential and actual capabilities under interference conditions are evaluated. A broad range of measuring devices is theoretically examined, including single-channel and dual-channel single pulse units, and in the applied part of the book stress is placed on multichannel measuring devices performing space-time signal processing and providing simultaneous measurement of angular coordinates (direction finding) of several radiation or reradiation sources, the spectra of which are so close that selection based on velocity, distance and polarization characteristics is impossible.

The material is set out in the following order. General principles for measuring the parameters of radio signals, a mathematical model for measurements and assumptions which are made during synthesis and analysis are described in Chapter 1. The definition of a communication channel is given. Chapter 2 is devoted to methods for analysis of multichannel measuring device accuracy. Methods for calculating mean values, standard correlation functions (coefficients of correlation) and measurement error dispersions caused by the appearance of external interference, the non-ideal nature of the channel characteristics and the appearance of several types of interference are set out in it; examples of calculation of these errors are given. In Chapter 3, the question of the resolution of multichannel measuring devices is discussed and methods for its calculation are presented. The physical essence of resolution is examined in detail.

Chapter 4 is devoted to synthesis of optimal multichannel measuring devices using a stage-by-stage optimization method. In the first stage, the characteristics of the measuring device components (the antenna system and receiver) are considered as given in general form, and the basic operations necessary to obtain optimal evaluations are determined, i.e. the structure of the equations which must be solved in order to obtain the evaluations is determined. In the second stage, conditions for the best (in the sense of minimum measurement error) conditions for conversion and the concrete characteristics of the antenna system and receiving channel corresponding to them are sought. Instances of synthesis of coherent and non-coherent measuring devices and of synthesis of single-frequency and multifrequency signals are examined.

In Chapter 5, the potential capabilities of multichannel measuring devices are determined, given simultaneous measurement of the parameters of signals from a group of radiation or reradiation sources, and conditions for the physical realizability of multivariate measurements and the requisite number of channels to provide for simultaneous measurement of the coordinates and parameters of a given number of sources are found.

Chapter 6 is devoted to methods for calculating the characteristics of multichannel measuring device components, and Chapter 7 to examples of the synthesis and analysis of multichannel measuring devices.

The material is selected by chapter so that it is possible to read them selectively.

The author expresses his deep thanks to Doctor of Technical Sciences Prof. M. V. Maksimov for his in-depth study of the manuscript and his valuable advice for its improvement, and also to Cand. of Technical Sciences L. N. Shustov, whose help and strong recommendations did much to determine the advent of this book.

The author expresses his thanks to the following reviewers: Dr. of Technical Sciences Prof. A. P. Lukoshkin and Candidates of Technical Sciences A. K. Zhuravlev and A. D. Dalmatov for their helpufl comments which improved the manuscript.

Moreover, the author expresses gratitude to Dr. of Technical Sciences Prof. I. Ya. Kremer, Candidates of Technical Sciences V. I. Vladimirov, A. L. Doktorov and I. I. Makovetskiy and other comrades who participated in discussion of the manuscript, as well as to engineer M. N. Lysikova, who took upon herself the task of approbation of the mathematical computations and preparation of the manuscript.

The author is grateful beforehand to all of the readers who will send in comments on the book's contents to the following address: 101 000, Moscow, Glavpochtampt [Main Post Office], A/Ya 693, "Sovetskoye radio" Publishing house.

CONTENTS

[158-9194]

9194
CSO: 1860

UDC 621.395.52(035)

COMMUNICATIONS NETWORK EQUIPMENT

Moscow APPARATURY SETEY SVYAZI in Russian 1980 (signed to press 1 Jan 80) pp 2, 437-440

[Annotation and table of contents from book "Communications Network Equipment", by Mikhail Isaakovich Shlyakhter, El'vira Nikitichna Durbanova, Mariya Ivanovna Polyakova and Shovkat Galyamovich Galiullin, Izdatel'stvo "Svyaz'", 27,000 copies, 440 pages]

[Text] Key technical data are presented on series-produced equipment of transmission systems of YeASS [Unified Automated Communications Network] trunk line, intrazonal and local networks. Technical data are also presented on some types of equipment removed from production but still widely used in networks. Its purpose, type of communications line, electrical characteristics, construction, composition, and the like are indicated for each type of equipment.

Intended for engineering and technical personnel involved in designing, building and servicing transmission systems.

CONTENTS

[166-8831]

8831
CSO: 1860

DESIGNING STABILIZED POWER SUPPLIES FOR RADIOELECTRONIC EQUIPMENT

Moscow PROYEKTIROVANIYE STABILIZIROVANNYKH ISTOCHNIKOV ELEKTROPITANIYA RADIOELEKTRONNOY APPARATURY in Russian 1980 (signed to press 10 Jul 80) pp 2, 287-288

[Annotation and table of contents from book "Designing Stabilized Power Supplies for Radioelectronic Equipment" by Lyus'yen Adol'fovich Kraus, Genrikh Viktorovich Geyman, Mikhail Markovich Lapirov-Skoblo and Vasiliy Ivanovich Tikhonov, Izdatel'stvo "Energiya", 20,000 copies, 288 pages]

[Text] In this book the designing is discussed and calculations are presented of stabilized secondary power supplies. Electric circuits are presented, a brief description of their operating principle is given, and the selection of circuits satisfying specific technical requirements is provided a basis. The procedure for and examples of the calculation of circuits are presented in each chapter.

This book is intended for engineering and technical personnel involved in developing power supplies and for students specializing in radio engineering fields at VUZ's, as a designing textbook.

CONTENTS

[155-8831]

8831
CSO: 1860

UDC 621.396.965.621.391.26

DETECTION OF MOVING OBJECTS

Moscow OBNARUZHENIYE DVIZHUSHCHIKHSYA OB"YEKTOV in Russian 1980 (signed to press 18 Sep 80) pp 2-4, 286-287

[Annotation, foreword and table of contents from book "Detection of Moving Objects", by Petr Alekseyevich Bakut, Yuliya Vasil'yevna Zhulina and Nikolay Andreyevich Ivanchuk, Izdatel'stvo "Sovetskoye radio", 6000 copies, 287 pages]

[Text] The book is devoted to problems of the optimization of information processing, decision making and observation control when detecting and measuring moving objects and parameters appearing at random moments in time. Similar problems are encountered in a number of areas of modern technology, including radar, sonar, and light detection, astronomy and microparticle recording in experimental physics. The exposition is made from the unified positions of the theory of statistical solutions. Much attention is devoted to questions of practical realizability and to analysis of the efficiency of the proposed optimal and suboptimal information processing and observation control of algorithms. The fundamental results contained in the monograph were obtained by the authors, and are being published for the first time.

The book is intended for scientific workers and engineers specializing in the area of statistical signal processing and control in information systems, and it may also be useful to graduate students and students in advanced courses in the corresponding specialties.

Figures 24; tables 1; references 59.

FOREWORD

The book is devoted to problems of the optimization of information processing, decision making and observation control when detecting and measuring moving objects and parameters appearing at random moments in time.

The necessity of solving these problems has been dictated by the development of modern technology. Progress in the development of modern radar technology and sonar and light detection and in the development of highly sensitive instruments for recording microparticles in experimental physics resulted in the creation of complex multichannel information systems with high information,content which are capable of operating in the presence of noise and interference of various types, and which permit flexible and rapid control of their operation directly as information is being obtained.

The fact that within such systems information concerning several physical objects is processed simultaneously, the number of objects and the size of their parameters being random and varying randomly with time, is a significant feature in the functioning of such systems; objects which cease to exist or which pass beyond the bounds of the informations system's control zone are replaced by new ones. This results in a certain specific nature in the mathematical posing of the problem and in the need for using non-traditional mathematical models.

In the book, the mathematical problem is formulated as a statistical problem of detecting and evaluating the parameters of a random flow of objects on the basis of information contained in the stream of signals which is statistically associated with it. Such a statement of the problem is most natural and most adequately reflects the physical side of the phenomena; however, it has not as yet found an adequate complete reflection in the literature on the statistical theory of signal processing.

The authors examine this problem from the position of the theory of statistical solutions. While resolving it, it was necessary to use the methods of the theory of random currents [11], the device of recursion equations for the a posteriori characteristics of Markov processes [47] and the methods of sequential detection of spontaneously arising effects [58], as well as certain concepts and methods of information theory.

Exposition of the material is primarily oriented towards radar problems, and concrete models of signals and interference as well as terminology have been borrowed from radar detection. Nevertheless, the results have an adequately general nature and may be used directly in the related areas enumerated above. Not limiting themselves to a formal synthesis of optimal decision principles, the authors also examine questions of the practical realizability and the analysis of the effectiveness of the proposed optimal and suboptimal algorithms of information processing and observation control.

Chapter 1 is written by P. A. Bakut, Chapter and paragraphs 4.2 and 4.4 of Chapter 4 by Yu. V. Zhulina and Chapter 3 and paragraphs 4.1, 4.3, 4.5 and the appendix by N. A. Ivanchuk. The book was edited by P. A. Bakut.

CONTENTS

[157-9194]

9194
CSO: 1860

ELECTROPHYSICAL PROBLEMS IN THE USE OF SUPERCONDUCTION

Leningrad ELEKTROFIZICHESKIYE PROBLEMY ISPOL'ZOVANIYA SVERKHPROVODIMOSTI in Russian 1980 (signed to press 15 Apr 80) pp 2, 254-255

[Annotation and table of contents from book "Electrophysical Problems in the Use of Superconduction", by Igor' Alekseyevich Glebov, Charl'z Laverik and Valentin Nikolayevich Shakhtarin, Izdatel'stvo "Nauka", 1250 copies, 256 pages]

[Text] A discussion is presented of the state of the art of research on the practical application of superconduction in our country and abroad; characteristics of superconducting series-produced winding wires are given; modern ideas regarding the magnetic properties of superconductors and the nature of the critical state are discussed; methods of calculating losses in superconducting conductors from the effect of a variable magnetic field are presented. Methods of calculating magnetic fields, electrodynamic forces and mechanical stresses are discussed. On the basis of domestic and foreign experience in the development and creation of specific devices utilizing superconductors--magnetic systems, electrical machines, electrotransmission lines, tokamaks, etc.--an analysis is given of problems in the practical application of superconduction.

CONTENTS

[165-8831]

8831
CSO: 1860

UDC 621.394.1+621.397.7

FACSIMILE TRANSMISSION

Moscow PEREDACHA FAKSIMIL'NYKH IZOBRAZHENIY in Russian 1980 (signed to press 22 Jul 80) pp 2, 214-215

[Annotation and table of contents from book "Facsimile Transmission", by Yevgeniy Loginovich Orlovskiy, Izdatel'stvo "Svyaz'", 2200 copies, 215 pages]

[Text] The author discusses theoretical problems of electrical transmission of images by means of facsimile equipment.

He analyzes the characteristics of the most substantial transformations to which the image is subjected in the process of facsimile transmission in the analyzing and synthesizing devices. He examines the effects of the properties of vision on the requirements for the quality of facsimile reproductions, including the quality of the reproduction of half-tone gradations and small details of the image. The principles of the method of subjective evaluation of the quality of images are used in evaluating the effects of individual elements of facsimile communication on the quality of transmission, which makes it possible to optimize the characteristics of these elements and the entire communication for the purpose of controlling the quality of the images being received.

The author gave a classification and examples of designs of various sweep systems, as well as a method of illumination engineering calculations of light optics systems in such devices. He examines special characteristics of sweep systems for space phototelevision cameras.

A separate chapter deals with various recording methods used in synthesizing devices, discussing the characteristics of photographic recording in greater detail.

Theoretical problems of the transmission and reproduction of half-tone gradations are examined with consideration of distortions introduced during the analysis and synthesis of images, as well as of distortions occurring due to the presence of interference in the communication channel. Theoretical problems of the transmission of color images are discussed separately. The author gives examples of equipment used for color fascimile transmission, as well as of devices used in color polygraphy.

Information is given on the use in facsimile techniques of methods for reducing the redundancy of signals and effective coding. The uses of various methods of coding are illustrated by concrete examples.

Discussions of theoretical problems are accompanied by examples of their solutions in concrete facsimile equipment. Descriptions of fascimile equipment for various purposes are given, and equipment for newspaper transmission is treated in detail.

Prospects for the development of facsimile communication are determined on the basis of the modern tendencies in the development of theoretical and practical problems of facsimile transmission.

The book is intended for those engaged in the problems of the transmission of facsimile images.

Figures -- 138, tables -- 8, bibliography -- 157 items.

Contents

[168-10,233]

10,233
CSO: 1860

GALLOPING IN OVERHEAD POWER TRANSMISSION LINES

Alma-Ata PLYASKA PROVODOV VOZDUSHNYKH LINIY ELEKTROPEREDACHI in Russian 1979 (signed to press 18 Sep 79) pp 2, 151

[Annotation and table of contents from book "Galloping in Overhead Power Transmission Lines" by Revgat Mukhsinovich Bekmet'yev, Alman Sharapiyevich Zhakayev and Nikolay Vasil'yevich Shirinskikh, Izdatel'stvo "Nauka" Kazakhskoy SSR, 1500 copies, 152 pages]

[Text] This monograph is devoted to a theoretical and experimental study of the intense low-frequency vibrations of wires and cables of overhead power transmission lines, known as galloping.

Physical and mathematical models of the vibration process are discussed, along with a procedure for estimating the possible amplitude of galloping, based on an analysis of the energy balance of the vibration process. A study is made of the influence of key factors on the intensity of galloping. A description is given of a procedure for the artificial excitation of galloping in test sections of power transmission lines.

Considerable attention is paid to measures for combating galloping. A classification of methods of protecting power transmission lines from galloping is suggested, and the operating principles and design features of various types of dampers and methods of calculating them are described.

This book is intended for a wide range of engineering and technical and scientific personnel involved in designing and servicing electrical networks, as well as for students and graduate students at VUZ's in the appropriate fields of specialization.

CONTENTS

[156-8831]

8831
CSO: 1860

UDC 621.316.37.002.72(03)

HANDBOOK FOR THE INSTALLATION OF SWITCHGEAR OVER 1000 VOLTS IN ELECTRIC POWER STATIONS AND SUBSTATIONS

Moscow SPRAVOCHNIK PO MONTAZHU RASPREDELITEL'NYKH USTROYSTV VYSHE 1000 V NA ELEKTROSTANTSIYAKH I PODSTANTSIYAKH in Russian 1979 (signed to press 30 Oct 79) pp 2, 341-344

[Annotation and table of contents from book "Handbook for the Installation of Switchgear Over 1000 Volts in Electric Power Stations and Substations", by Yuriy Ivanovich Ryabtsev and Georgiy Georgiyevich Tiranovskiy, Izdatel'stvo "Energiya", 40,000 copies, 344 pages]

[Text] In this handbook is presented the technology for installing the electrotechnical equipment of 6 to 20 kV enclosed and 35 to 500 kV open RU's [power switchboards] and power tranformers. The first edition came out in 1971. In the second edition are discussed the installation of new types of equipment and new methods of installation and new gear and equipment are described.

This handbook is intended for engineering and technical personnel, foremen, work superintendents and skilled workers involved in the installation of electric power station and substation electrotechnical equipment.

CONTENTS

[163-8831]

8831
CSO: 1860

UDC 621.396.932(031)

HANDBOOK ON SHIP'S RADIO COMMUNICATION EQUIPMENT

Leningrad SPRAVOCHNIK PO SUDOVOMU OBORUDOVANIYU RADIOSVYAZI I RADIO NAVIGATSII, TOM 1: OBORUDOVANIYE RADIOSVYAZI in Russian (signed to press 2 Nov 79) pp 2-4, 335-336

[Annotation, foreword and table of contents from book "Handbook on Ship's Radio Communication Equipment and Radio Navigation, Vol 1, Radio Communication Equipment" by Marat Vladimirovich Vershkov, Aleksandr Sergeyevich Zudov, Li Za Son, Viktor Alekseyevich Markov, Nikolay Timofeyevich Nichiporenko, Eduard Karlovich Putraym, and Konstantin Aleksandrovich Semenov, edited by Professor K. A. Semenov, doctor of technical sciences, Izdatel'stvo "Sudostroyeniye", 12,000 copies, 336 pages]

[Text] Volume 1 of this handbook gives basic specifications of the ship's antenna feeders, ship's radio-transmitting and radio-receiving equipment, standby (emergency) communication facilities, radio stations of intermediate, decametric and metric waves, command transmission facilities, and terminal telegraph equipment.

This handbook is intended for engineers and technicians specializing in the development of individual types of ship's radio equipment, as well as for workers of designing and assembling enterprises and operation services of the maritime, fishing and river fleets.

Foreword

In connection with the growth of the tonnage and increasing speeds, dimensions, and time lag of modern vessels, the requirements for the safety of navigation have increased considerably. Radio navigation instruments used by the vessels of the maritime and fishing fleets are becoming very important. They make it possible to reduce the number of accidents causing great material damage, in some cases creating a real threat to the preservation of the environment.

Volume II of the handbook on ship's radio communication equipment and radio navigation describes modern domestically produced radio navigation instruments used on vessels of the maritime and fishing fleets. It gives functional circuits, block diagrams, operating characteristic specifications, and technical operation rules for radio navigation instruments.

Chapter 1 discusses aural ship radio direction finders of the types "Rybka" and "Barkas" and the"Rumb"-type two-channel visual radio direction finder.

Chapter 2 contains descriptions of ship receiving indicators of the types of "Pirs-1D" and "Pirs-1M" used for determining the position of the vessel by the signals of the shore stations of phase radio navigation system "Dekka".

Chapter 3 discusses the vessel receiving indicator of the type of KPI-5F which is used for the determination of the position of the vessel by the signals of shore stations of the pulse-phase radio navigation system "Loran-S".

Chapters 4 and 5 describe ship radars of the types of "Lotsiya", "Mius" and "Nayada" and automated navigation radars of the types of "Okean" and "Okean-M".

Chapter 6 discusses the special characteristics of the operation of navagational Doppler radars for measuring the mooring speed of the type of "Istra".

Chapter 7 discusses the ship infrared equipment for night vision of the type of "Mgla" and the television system "Gorizont".

Each chapter of the handbook ends with recommendations for the installation, assembling and operation of radio navigation instruments on the ship.

The development of the technical means of navigation in the last decade is characterized by a wide introduction of digital computers and the use of new principles of integration increasing the operational possibilities of the instruments. The realization of the schemes of digital processing of radio navigational information makes it possible to use the methods of optimal processing and presents navigational information in a form convenient for the navigator.

By the time when the work on the handbook was completed, experimental operation of the radar complex "Yenisey" started. The development of situation indicators with computers "Briz-Ye" and "Kron" is nearing completion. Their production will start in 1981.

The handbook was written by the following authors: foreword, introduction, and section 3.1 -- by K. A. Semenov; Chapter 1 -- by M. V. Vershkov; Chapter 2, sections 5.1-5.3, 7.4, 7.5, 8.1-8.5 -- by E. K. Putraym; sections 3.2-3.4, Chapters 4, 6, sections 7.1-7.3 -- by V. A. Markov; sections 5.4-5.6 -- by Li Za Son; section 7.6 -- by N. T. Nichiporenko; sections 8.6-8.9 -- by A. S. Zudov.

Besides the main authors, leading specialists of the ministries of the shipbuilding industry, navy, fisheries, and communication services participated in the compilation of the handbook.

Since this handbook has been created for the first time, it unavoidably has certain shortcomings, therefore the authors will be grateful for any remarks and suggestions of the readers which are to be sent to the following address: 191065, Leningrad, ul. Gogolya, 8, Izdatel'stvo "Sudostroyeniye".

Contents

[172-10,233]

10,233
CSO: 1860

HIGH-FREQUENCY-OSCILLATION POWER SUMMATION AND DISTRIBUTION EQUIPMENT

Moscow USTROYSTVA SLOZHENIYA I RASPREDELENIYA MOSHCHNOSTEY VYSOKOCHASTOTNYKH KOLEBANIY in Russian 1980 (signed to press 10 Jul 80) pp 2, 293-295

[Annotation and table of contents from book "High-Frequency-Oscillation Power Summation and Distribution Equipment" by Vitaliy Vladlenovich Zayentsev, Valentina Mikhaylovna Katushkina, Semen Yefimovich London and Zinoviy Iosifovich Model', Izdatel'stvo "Sovetskoye radio", 5000 copies, 296 pages]

[Text] The fundamentals of the theory and engineering calculation of high-frequency- and microwave-oscillation power summation and distribution bridge equipment are discussed, and various types of bridge devices constructed on the basis of elements with distributed and lumped parameters and designed for various wave bands are discussed. New solutions are presented for multiterminal and wideband equipment, in particular, of the transformer type, as well as for transformers themselves.

Distinctive features of the bridge summation and distribution of power under actual conditions of the operation of radio transmitting equipment are discussed, as well as questions relating to the summation of the power of self-excited oscillators. Questions are discussed, relating to the summation of power in stripline microwave devices.

This book is intended for specialists involved in creating radio engineering equipment for the high-frequency and microwave bands; it will also be useful to teachers and students at radio engineering VUZ's.

CONTENTS

[154-8831]

8831
CSO: 1860

UDC 621.315.2.002.72

INSTALLATION OF SPECIAL AND CONTROL CABLES

Moscow MONTAZH SPETSIAL'NYKH I KONTROL'NYKH KABELEY in Russian 1980 (signed to press 1 Sep 80) pp 2, 96

[Annotation and table of contents from book "Installation of Special and Control Cables", by Nikolay Mikhaylovich Nekrasov and Georgiy Georgiyevich Tiranovskiy, Izdatel'stvo "Energiya", 25,000 copies, 96 pages]

[Text] Methods are presented for the fabrication and installation of heat-resistant, marine, coaxial, heat- and radiation-resistant and control cables used in secondary circuits of heat and power plants and nuclear power plants. Descriptions are given of the equipment and tools used for outfitting technological lines for the fabrication of cables.

This book is intended for foremen, crew leaders and electrical installers carrying out the installation of cable lines and can be helpful to electricians involved in the maintenance of electrical equipment at electric power plants.

CONTENTS Page

[167-8831]

8831
CSO: 1860

MAGNETIC METALLIC FILMS IN MICROELECTRONICS

Moscow MAGNITNYYE METALLICHESKIYE PLENKI V MIKROELEKTRONIKE in Russian 1980 (signed to press 18 Mar 80) pp 2, 190-191

[Annotation and table of contents from book "Magnetic Metallic Films in Microelectronics", by Robert Dmitriyevich Ivanov, Izdatel'stvo "Sovetskoye radio", 6000 copies, 192 pages]

[Text] The basic steps in the formation of metallic films are discussed. The main methods of applying films are described in fairly great detail, such as vacuum spraying, electrolytic deposition and cathode sputtering. Special attention is paid to cathode sputtering as the most promising method of creating magnetic film elements of large-scale integrated circuits. The magnetostatic, electrical, structural and mechanical properties of magnetic metallic films are presented, as well as the conditions for producing films for their use in engineering. The degree of aging of magnetic films produced by various methods is demonstrated, as well as the influence of annealing on degradation of the properties of films. An indication is given of the major areas of application of magnetic metallic films in microelectronic devices, both as a storage medium and as functional elements of integrated circuits. A description is given of the technology for producing integrated circuits employing cylindrical magnetic domains for storage devices.

This book is intended for specialists working in the field of film microelectronics, as well as for technologists developing processes for creating magnetic integrated circuits. It can also be helpful to students and graduate students in the appropriate fields of specialization.

CONTENTS

[153-8831]

8831
CSO: 1860

WIDEBAND INTEGRATED AMPLIFIERS

Moscow SHIROKOPOLOSNYYE INTEGRAL'NYYE USILITELI in Russian 1980 (signed to press 18 Mar 80) pp 2, 223

[Annotation and table of contents from book "Wideband Integrated Amplifiers" by Vladislav Fedorovich Lamekin, Izdatel'stvo "Sovetskoye radio", 25,000 copies, 224 pp]

[Text] In this book are discussed questions relating to the design and aspects of the creation of wideband amplifiers based on linear integrated circuits, used in the construction of receiving channels of radar, communications and navigation systems, as well as in measuring and computing equipment. Various high- and low-frequency correction circuits are analyzed and procedures are presented for calculating them. Wideband integrated amplifiers which have been created are described and examples are presented of the calculation of basic radio engineering circuits based on them.

This book is intended for specialists involved in the development and creation of radio engineering and communications equipment in which wideband amplifiers are used and will also be useful to graduate students and students majoring in radio engineering at VUZ's.

CONTENTS

[152-8831]

8831
CSO: 1860

UDC 621.382:621.3.049.77

MICROELECTRONICS AND SEMICONDUCTOR DEVICES

Moscow MIKROELEKTRONIKA I POLUPROVODNIKOVYYE PRIBORY in Russian 1980 (signed to press 17 Jul 80) pp 2, 311-312

[Annotation and table of contents from book "Microelectronics and Semiconductor Devices", edited by Aleksandr Anatol'yevich Vasenkov and Yakov Andreyevich Fedotov, Izdatel'stvo "Sovetskoye radio", 10,000 copies, 320 pages]

[Text] In this collection are published articles by authors in our country on the following questions: general problems and physical fundamentals of semiconductor microelectronics, fundamentals of the technology of semiconductor devices and integrated circuits, methods of testing, the design of microelectronic equipment and the fabrication technology for it, optoelectronics, and new trends in microelectronics.

A large section is devoted to studying the properties of promising semiconductor microwave devices, to studying features of their operation in various pieces of equipment, and to a discussion of modern ideas and trends in the development of PZS's [charge-coupled devices].

Intended for specialists and scientific personnel involved in developing, fabricating and using semiconductor devices and integrated circuits.

CONTENTS Page

[162-8831]

8831
CSO: 1860

UDC 621.369.67

NEW BOOK OF COLLECTED PAPERS ON ANTENNA DESIGN

Moscow ANTENNY in Russian No 28, 1980 (signed to press 18 Sep 80) pp 2, 179-82

[Annotation and abstracts of papers in the book "Antennas: Collected Papers, Volume 28", edited by A. A. Pistol'kors, Izdatel'stvo "Svyaz'", 7,000 copies, 184 pages]

[Text] Questions of the interaction of poorly directional antennas are treated as well as the improvement of the direction finding precision in antenna arrays with discrete phasing and questions of calculating the radiation characteristics of pyramidal horn antennas. A number of papers is devoted to the design of microstrip line systems and the current distributions over the surface of an ideally conducting wedge.

Abstracts of Articles

UDC 621.396.677.833.2

THE MILLIMETER WAVELENGTH RT-7.5 RADIOTELESCOPE ANTENNAS OF THE MOSCOW HIGHER ENGINEERING SCHOOL

[Abstract of article by Kugushev, A.M. [deceased], Kalachev, P.D., Pershikov, A.A., Rozanov, B.A. and Fetisov, I.N.]

[Text] The design, fabrication procedure and alignment of the reflecting surface are described as well as the results of the study of the production process errors, the weighting and thermal deformations and the electrical characteristics of the fully steerable RT-7.5 parabolic antennas of the MVTU [Moscow Higher Engineering School] radiotelescope, having a diameter of 7.75 m and designed for operation at short millimeter wavelengths right down to a wavelength of 1 mm. Figures 7; references 11.

UDC 621.396.67

ON THE CALCULATION OF THE TRANSIENT PROCESSES IN AN ADAPTIVE ANTENNA ARRAY

[Abstract of article by Pistol'kors, A.A.]

[Text] A method is given for the calculation of transient processes in an adaptive antenna array which leads to a system of differential equations in which the unknowns are the values of the steady-state directional pattern for each of the interference sources, while the number of equations is equal to the number of interference sources. Cases of one and two interferences sources are studied in detail as well as the impact of the elements of the adapting network on the dynamic process. Figures 2; references 5.

UDC 621.396.677.494:621.396.677.85

A SURROUNDING SHELL LENS TO INCREASE THE SCANNING SECTOR OF A PLANE PHASED ANTENNA ARRAY

[Abstract of article by Bubnov, G.G., Korostyshevskiy, Ye.N. and Sergeyev, V.N.]

[Text] For an antenna array with a narrow directional pattern, the product of the gain times the scanning sector is governed by the number of controlling elements. One of the well known ways of increasing the scanning sector of a plane phased antenna array by means of reducing the gain is a phased antenna array component with a lens having the properties of a refracting prism. Figures 3; references 6.

UDC 626.396.676.85

ON THE PROBLEM OF OPTIMIZING A LENS TYPE ANTENNA FEED

[Abstract of article by Lemanskiy, A.A. and Pan'shina, G.P.]

[Text] The results of optimizing several types of lens antenna feeds are given. The otimization was performed to obtain the maximum value of KIP [surface utilization factor] of the antenna. An estimate is given for the possibility of boosting the KIP of a lens antenna through changing the profile of the irradiated side of the lens. KIP values obtained with a precise and approximate description of the directional pattern of the feed irradiator are compared. The results of optimizing a combination receiving and transmitting lens antenna feed irradiator are given. Figures 7; references 7.

UDC 621.396.673

THE DETERMINATION OF THE MUTUAL IMPEDANCES OF RADIAL DIPOLES AND THE CURRENT DISTRIBUTION AT THE SURFACE OF A WEDGE WITH CIRCULAR ROUNDING ABOUT THE EDGE

[Abstract of article by Kravtsov, V.A. and Dyuzhkova, L.B.]

[Text] Expressions are derived to determine the resonant and mutual impedances of radial dipoles, positioned close to a wedge with cicular rounding about the edge, as well as the density of the surface currents on the surface of the solid under consideration. The results are given for the calculation of the resonant and mutual impedances of the radial dipole as well as the density of the surface currents excited in the solid by a radial dipole. Figures 9; references 6.

UDC 621.396.677

THE INTERACTION OF LOW GAIN ANTENNAS

[Abstract of article by Martsafey, V.V. and Sorodovnikov, M.A.]

[Text] The interaction between two low gain antennas located within the shadow zone of each other is studied, one of which is an aperture type antenna. It is shown that by focusing the field produced by the sources located within the aperture antenna shield, an additional gain can be obtained in the decoupling between the antennas. Results are given for an experimental study as well as calculations for a two-dimensional model. Figures 4; references 2.

UDC 621.396.677

ON THE INTERACTION OF ANTENNA ARRAYS

[Abstract of article by Martsafey, V.V. and Shvayko, I.G.]

[Text] Questions of the interaction between antenna arrays composed of slotted radiators are treated. Results are given for the calculation of the levels of interaction between arrays when the distance between them is changed, as well as for the amplitude and phase distributions in the arrays. Figures 5; references 4.

UDC 621.396.674.37

THE EMISSION FROM AN ANNULAR SLOTTED ANTENNA POSITIONED AT THE SURFACE OF THE EARTH

[Abstract of article by Konstatinova, A.A.]

[Text] An expression is derived in an approximation of physical optics for the directional pattern of an antenna which takes the form of an annular slot of finite widths, cut in an ideally conducting, infinitely thin disk with a large radius, lying on the surface of the earth. Figures 5; references 4.

UDC 621.396.677

ON THE DIRECTIONALITY OF LINEAR ANTENNA ARRAYS IN MOBILE VHF RADIO COMMUNICATIONS SYSTEMS

[Abstract of paper by Lavrent'yev, N.V.]

[Text] It is shown based on an analysis of the electromagnetic field spatial correlation functions under conditions of multipath propogation that the directional pattern of linear antenna arrays is widened. The nulls of the directional pattern disappear and the pattern itself is smoothed out, approaching an omnidirectional pattern with a decrease in the correlation interval. Figures 2; references 4.

UDC 621.396.677

THE ANGULAR DISPLACEMENT OF THE DIRECTIONAL PATTERNS OF ARC ARRAYS WHEN INDIVIDUAL PHASE SHIFTS ARE MADE IN INDIVIDUAL RADIATORS

[Abstract of article by Bagin, G.T. and Gromov, A.I.]

[Text] An esimate is made of the angular displacement of a beam for the sum and difference directional pattern based on the position of the extremal points of the main lobe. The analysis is made by means of referencing the arc arrays to an equivalent linear aperture. Formulas are derived for the minimal beam displacements in the cases of arbitrary and equal amplitude excitation of the elements. It is determined that the sum directional pattern have the minimum beam jump which is less than the difference patterns by the amount of the order of the number of radiating elements. Figures 3; references 3.

UDC 621.396.677.494

INCREASING THE DIRECTION FINDING ACCURACY IN ANTENNA ARRAYS WITH DISCRETE PHASING

[Abstract of article by Novoselov, Ye.K., Potravko, V.F., Chernyshov, V.S. and Shpuntov, A.I.]

[Text] A method of improving the direction finding precision in antenna arrays with discrete phasing is analyzed. The method is based on the averaging of the angular coordinates of the target during its repeated sensing with a change in the picture of the phase errors in the phased antenna array elements from one probe period to the other. A quantitative analysis is made of the impact of the averaging method on the angular errors due to the discrete phasing. The specific features of the application of the method to reflective phase antenna arrays are studied. The results of an experimental check are given. Figures 7; references 10.

UDC 621.396.67

A BROADBAND STRIPLINE RADIATING ELEMENT

[Abstract of article by Vayner, Yu.A., Gural', I.M. Konyashenko, Ye.A., Moiseyev, A.G. and Shmykov, V.N.]

[Text] A model is proposed for a broadband "grooved" radiator, which provides for an SWR of less than two in an octave range. Figures 6; references 7.

UDC 62.396.677.3

THE FIELD OF TWO RADIAL ELECTRICAL DIPOLES BENEATH AN ELONGATED IDEALLY CONDUCTING SPHEROID

[Abstract of article by Donchenko, V.N.]

[Text] The problem of the asymmetrical excitation of a spheroid by two radial elementary electrical dipoles is solved by an eigen function technique in a spheroidal system of coordinates. Results are given for the calculation of the directional patterns of dipoles positioned close to a spheroid of small electrical dimensions. Figures 8; references 7.

UDC 621.396.677.494

THE EXCITATION OF AN OPEN RESONATOR WITH A DIFFRACTION GRATING BY AN ELECTRON FLOW

[Abstract of articles by Sulima, A.V. and Shmat'ko, A.A.]

[Text] The problem of the excitation of an open resonator with a grating is solved in a formulation with the current specified and an approximation of the narrow slots of the diffraction grating. Analytical expressions are derived for the amplitude of the field radiated by the resonator and for the coefficients of the field expansion in the resonator. The directional patterns are given for the structure studied here. The specific physical features of the emission are ascertained. Figures 3; references 3.

UDC 621.372.852.2

THE CALCULATION OF THE DISPERSION IN MICROSTRIP LINE INTERACTING SYSTEMS OF THE 'MEANDER' AND 'OPPOSING PINS" TYPE ON A MAGNETODIELECTRIC SUBSTRATE

[Abstract of paper by Zosim, V.D. and Yurgenson, R.R.]

[Text] Dispersion equations are derived using a variational technique for a "meander" system and the method of period multipole network theory for an "opposing pins" system. The results of the dispersion calculations are given which are compared to experimental data. Figures 5; references 15.

UDC 621.372.852.2(088-8)

PHASE SHIFTS IN A MICROSTRIP LINE ON A FERRITE SUBSTRATE WITH A MEANDER STRIP

[Abstract of article by Yurgenson, R.R.]

[Text] The perturbation method is used to derive the differential phase shifts in a microstrip line: it is uncoupled in the case of the transverse magnetization and coupled for the orthogonal (longitudinal-transverse) magnetization of the ferrite substrate. The results of the calculation are given and a comparison is made of the indicated phase shift. Figures 1; references 6.

UDC 621.372.832.81

THE CALCULATION OF THE CHARACTERISTICS OF A MICROSTRIP Y-CIRCULATOR ON A FERRITE FILM TAKING ABSORPTION INTO ACCOUNT

[Abstract of article by Kheyfets, S.B.]

[Text] The Galerkin-Ritts technique is used in conjunction with an iteration procedure to solve a system of linear algebraic equations and find the elements of the impedance matrix of a microstrip Y-circulator on a ferrite film, taking into account the absorption in the medium. Expressions are derived which relate the values of the impedance matrix elements to the geometric dimensions of the circulator and the electrical parameters of the ferrite film and substrate. The working characteristics of the circulator are determined from the known impedance matrix. Figures 5; references 3.

UDC 621.372.061

A COMPARISON OF THE FREQUENCY CHARACTERISTICS OF STRIPLINE MICROWAVE POWER DISTRIBUTION SYSTEMS

[Abstract of article by Konin, V.V.]

[Text] Parallel stripline power distribution systems (SPDS's) with uniform division are analyzed which are made of ring bridges, dual channel directional dividers, symmetrical ring bridges and bridges of linked squares. The frequency characteristics of SPDS's are given. A comparative analysis is made of SPDS's and practical recommendations are formulated for the design of SPDS's. Graphs are given for taking into account the influence of the lengths of ballast resistors in the planning and design of SPDS's made of dual channel directional dividers. It is shown using the example of a 4,096 channel SPDS that systems designed around dual channel directional dividers have the greatest bandwidth. Figures 5; references 9.

UDC 621.396.677

THE NOISE TEMPERATURE AND THE NOISE QUALITY FACTOR OF IN-PHASE ANTENNA ARRAYS

[Abstract of article by Somov, A.M.]

[Text] A method is proposed for the calculation of the noise temperature (NT) and noise- Q (NQ) of antennas in the form of in-phase arrays for satellite reception. The noise temperature is studied as a function of the angle of inclination of the antenna and the number of radiating low gain elements. It is proposed that each of the array elements of highly directional reflecting radiators be optimized to obtain a high noise Q. Figures 10; references 4.

UDC 621.317.743.7

THE QUALITY OF MODERN ANECHOIC CHAMBERS AND RADIO ABSORBENT MATERIALS

[Abstract of article by Mitsmakher, M.Yu.]

[Text] The specific features of radio absorbent materials for anechoic chambers are ascertained on the basis of an analysis of the requirements placed on modern anechoic chambers, the physical principles of the broadband matching of absorbing media to free space and their specific realization in various radio absorbent materials. The diffraction field of a fracture in the absorbing surface of a chamber is analyzed as a function of the angular characteristics of the Fresnel reflection factor from the absorbing material. The requirements placed on the characteristics of radio absorbing material are formulated to achieve the best anechoic response of chambers with a profiled surface. Figures 9; references 14.

UDC 621.396.67:624.07

A SYSTEM OF STRAIN GAUGE WEIGHTS FOR MODEL AERODYNAMIC STUDIES OF AN ANTENNA

[Abstract of article by Polyak, V.S., Sinkevich, Yu.B., Tsvetayeva, A.A. and Sharova, S.Ye.]

[Text] A system of strain gauge weights is proposed which makes it possible to measure the six components of a wind load directly on the actuating axes of an antenna model. The structural designs of the force measurement devices are executed in the form of closed, prestressed systems consisting of combinations of distended plates and membranes. Figures 6.

UDC 621.396.67:624.07

A MEASUREMENT COMPLEX FOR FULL-SCALE MECHANICAL STUDIES OF ANTENNA STRUCTURAL DESIGNS

[Abstract of article by Polyak, V.S., Sokolov, A.G., Al'perin, V.M. and Polovchenya, I.Ye.]

[Text] An instrumentation complex for the mechanical studies of antenna structural designs is treated, which makes it possible to study the behavior of antenna structures under full-scale conditions in the presence of the actual destabilizing factors, and additionally, study the wind and temperature loads on the antenna. The complex was realized for the first time in the TNA-1500 radio telescope with the 64 meter antenna dish. Figures 10.

[174-8225]

8225
CSO: 1860

UDC 621.382:678.026(087.2)

PROTECTION OF SEMICONDUCTOR DEVICES BY POLYMERS

Minsk ZASHCHITA POLUPROVODNIKOVYKH PRIBOROV POLIMERAMI in Russian 1979 pp 109-10, 112

[Annotation and table of contents from book "Protection of Semiconductor Devices by Polymers", by P. I. Shved, Izdatel'stvo "Vysheyshaya shkola", 112 pages]

[Text] This monograph treats various aspects of one of the important technical trends in the electronic industry -- protection of semiconductor devices by polymeric materials. Information is given on optimal conditions of molding semiconductor devices with epoxy molding materials, on mechanical stresses in polymeric coatings and protected crystals of semiconductors, etc.

This monograph is intended for engineers and technicians engaged in the protection of semiconductor devices (as well as other articles) by polymeric materials. It will be useful to instructors and graduate students in the electronic and chemico-technological fields.

Contents

[173-10,233]

10,233
CSO: 1860

UDC 621.39:621.382

SEMICONDUCTOR ELECTRONICS IN COMMUNICATIONS ENGINEERING

Moscow POLUPROVODNIKOVAYA ELEKTRONIKA V TEKHNIKE SVYAZI in Russian 1980 (signed to press 20 May 80) pp 2, 225

[Annotation and table of contents from collection "Semiconductor Electronics in Communications Engineering: Collected Papers, Volume 20", edited by I. F. Nikolyevskiy, Izdatel'stvo "Svyaz'", 5,000 copies, 225 pages]

[Text] The measurement of interference in communications channels is treated; design calculations and the planning are given for transmitters, radio frequency oscillators, amplifers (including low-noise amplifiers), digital devices, power supplies; automatic gain control circuits in amplifiers and transmitters are analyzed; the results of an experimental study of the characteristics of bipolar and field-effect transistors in the nominal mode and in a micropower mode are given; the application of digital computers to the design of power supplies and modeling equivalent circuits of semiconductor devices; the prospects for the use of miniature speech telephone information devices designed around LSI's; and the characteristics of piezoelectric voltage transformers. Reference data are given on the characteristics of high power oscillator and amplifier transistors for the short wave and ultrashort wave bands.

The book is intended for engineering, technical and scientific workers engaged in the development and design of communications equipment using semiconductor devices, and can be useful to a broad group of specialists working in the field of semiconductor electronics.

Table of Contents

[139-8225]

8225
CSO: 1860

UDC 621.314.2.001.4

TESTING TRANSFORMERS WITH POWER RATINGS UP TO 6300 kVA AND VOLTAGES UP TO 5 kV

Moscow ISPYTANIYE TRANSFORMATOROV MOSHCHNOST'YU DO 6300 KV-A I NAPRYAZHENIYEM DO 35 KV in Russian 1980 (signed to press 12 Sep 80) pp 2, 309-312

[Annotation and table of contents from book "Testing Transformers With Power Ratings up to 6300 kVA and Voltages up to 35 kV", by Yevsey Aronovich Kaganovich and Il'ya Markovich Raykhlin, Izdatel'stvo "Energiya", 12,000 copies, 312 pages]

[Text] Programs and methods of performance, acceptance and periodic testing of general service, special and household service transformers during fabrication and repair are treated. Methods are described for flaw detection during testing and repair, as well as programs for prerepair and post-repair testing. Recommendations are given for the choice of the test equipment and measurement facilities.

The book is intended for engineering and technical workers engaged in the testing of transformers during fabrication, repair and operation, as well as the design of testing stations and individual test units.

Table of Contents

[136-8225]

8225
CSO: 1860

UDC 621.319.4

THE USE OF CAPACITORS IN ELECTRONIC AND ELECTRICAL EQUIPMENT

Kishinev PRIMENENIYE KONDENSATOROV V ELEKTRONNYKH I ELEKTRO-TEKHNICHESKIKH USTANOVKAKH in Russian 1979 (signed to press 25 Jan 79) pp 2, 88

[Annotation and table of contents from collection "The Use of Capacitors in Electronic and Electrical Equipment", edited by L. F. Bragina and N. N. Murashova, Izdatel'stvo "Shtiintsa", 815 copies, 88 pages]

[Text] Urgent questions are treated in this collection; the application of capacitors in electrical and electronic equipment; the specific features of the operation of capacitors in nonstandard modes, in particular, when subjected to pulsed loads; the calculation of the thermal fields and permissible electrical loads of capacitors under the specified conditions; certain requirements placed on the capacitors of semiconductor power converters; diagnosing and predicting the service life of electrical capacitors, as well as some diagnostic models.

The collection is addressed to scientific workers and engineers engaged in questions of the application of capacitors in semiconductor power converters and other electrical power engineering facilities.

Table of Contents

[138-8225]

8225
CSO: 1860

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